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The Public and the Strike

WHO is going to pay for the strike? Are consumers to be charged enough for coal and railway service for the next two or three years to pay a profit on the current operation and to make up the lost profits and wages of the long strike period besides?

Has the public got to pay for the quarrels of the operators and miners and shopmen? If so, it ought to have something to say about the permissibility of one of these industrial wars that subject them to a draft upon their purses in addition to inconvenience and deprivation and danger.

The public has a right to know what the fuss is all about and how it is settled, and to decide whether the points at issue are of sufficient moment to have the social, industrial and transportation systems of the country crippled and disorganized in a scrap for the mastery.

Most of us would be willing to suffer and to pay to relieve the workingman of oppression or to resist an unjustifiable aggression upon the employer, but an injustice would have to be a glaring one to warrant the throwing of the whole country into the present deplorable condition, and when such an injustice exists there must be a more satisfactory way of correcting it.

The Power Plant in a Modern Sugar Refinery

By ROGER B. STEVENS*

ONE of the most interesting industrial power developments that have been made in the last few years is that in connection with the new refinery of the American Sugar Refining Company located on the Patapsco River at Baltimore, Maryland.

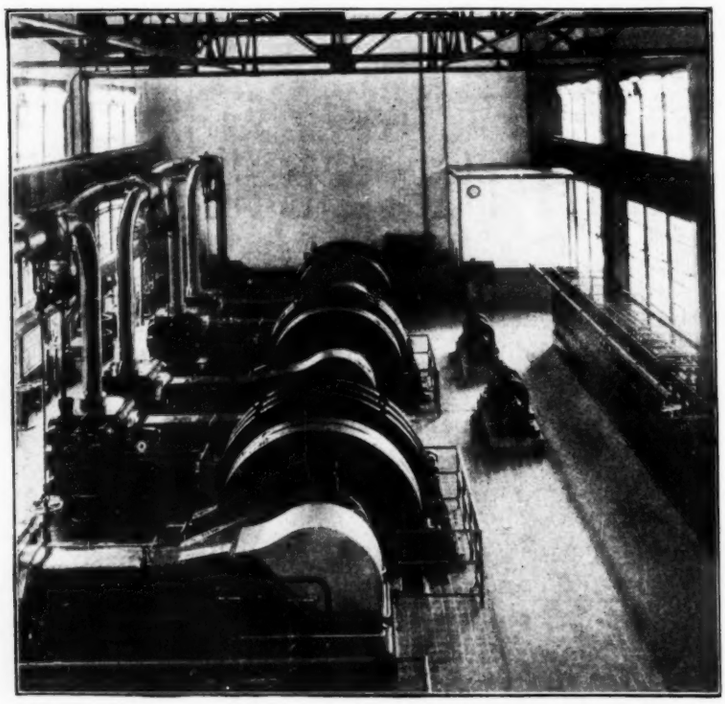

FIG. 1—VIEW OF ENGINE ROOM, SHOWING MAIN UNITS AND BALANCER SETS

The fact that the new plant, upon which a great deal of effort and money have been spent to make it the most modern and efficient of its kind, is equipped throughout with direct-current motor and power equipment has caused a good deal of discussion among industrial and power engineers ever since the plans were made public; and the further fact that the designers have "gone back" to Corliss engines as prime movers in the face of the present tendency in this and other industries of like size toward turbines has made the project even more interesting from an engineering point of view.

An explanation of the reasons for arriving at these decisions may possibly be of interest to engineers who have to do with industrial power, not only in the sugar industry, but for other purposes.

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Fifteen years ago the building of an extensive plant for the generation of direct current for industrial use by a single factory, or even for central-station service, would have caused no great amount of comment, but in the present state of development of alternating-current equipment, and in view of the general tendency to operate everything possible with alternating current, a great deal of discussion has been aroused.

The designer of an industrial plant finds, when he begins his work, that a number of conditions are already laid down and require no discretionary effort. He must begin his work with an exhaustive study of the manufactory which his plant is to serve. He may then find that there is a sufficient demand for exhaust steam so that greater over-all economy is to be obtained by operating his prime movers non-condensing; that the same boilers that furnish steam to the power plant must also furnish live steam to processes where superheat is a detriment rather than an advantage, and he must then decide between the added water rate of his prime movers on saturated steam and the expense and inconvenience of a separately-fired superheater or a boiler with integral superheater and two separate headers. In like manner the electrical characteristics require careful study from a different viewpoint—that of plant conditions—to determine, not the system that will give the most efficient and convenient operation of the power-generating apparatus, but the most efficient operation of the manufacturin plant as a whole, even at some sacrifice of an idea conditio in the steam and electric departments.

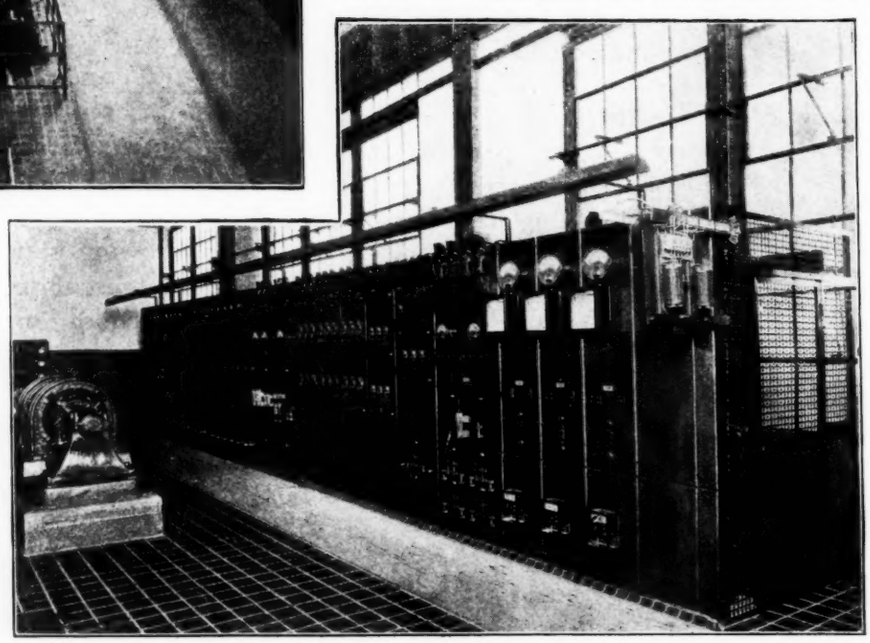


FIG. 2—CONTROL AND LIGHTING SWITCHBOARD

With the foregoing in mind the designers of the Baltimore Refinery made thorough studies of the conditions in existing refineries and preliminary studies of the proposed new plant, before arriving at a decision

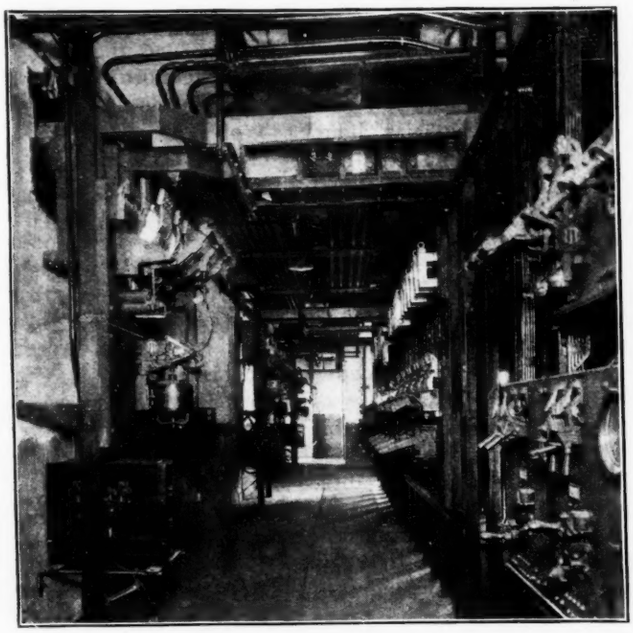


FIG. 3—SHOWS MAIN BUSBAR AND CIRCUIT-BREAKER STRUCTURE

as to the type of power to be used and the best method of generating it.

The result of these studies was that a plant having the following characteristics was designed and built:

Boiler Plant:
- Number of boilers installed 5
- Sq. ft. heating surface each 12,060
- Boiler pressure ..... 210 lb. (saturated)

Power Plant:
- Prime movers:
- Type ..... Twin side crank, non-releasing Corliss
- Manufacturer ..... Ridgway Dynamo and Engine Co.
- Number, ultimate 4
- Number, present 3
- Horsepower, each 1,880
- Speed, r.p.m. 135
- Pressure, throttle ..... 200 lb. (saturated)
- Pressure, back ..... 10 lb.

Generators:
- Type:
  - Thompson-Ryan compensated field engine type, 240-250 volts, two-wire, D.C.
- Manufacturer ..... Ridgway Dynamo and Engine Co.
- Capacity, each:
  - 1,250 kw. (full load) continuous; 25 per cent overload for two hours; 50 per cent overload for fifteen minutes.

Guaranteed performance of units, water rate:
- 35.9 lb. kw.-hr. at full load.
- 39.0 lb. kw.-hr. at 50 per cent load.
- 39.1 lb. kw.-hr. at 125 per cent load.

NOTE—In the article describing the boiler plant in the July 4 issue, the Edward Valve and Manufacturing Co. and the Nelson Valve Co. were inadvertently omitted in the valve schedule.—EDITOR.

As the boiler plant was thoroughly covered in an article in the July 4 issue of *Power*, no further description of it will be given here.

ADVANTAGES AND DISADVANTAGES OF THE TWO SYSTEMS

As between the two systems of generation, transmission and application of electric power, an analysis shows that each has points in its favor when applied to industrial purposes and each has certain inherent disadvantages. The chief characteristics may be summed up about as follows:

Alternating Current Advantages:

1. The squirrel-cage induction motor is probably the simplest machine ever developed for the translation of electrical energy into mechanical form, its first cost is low and its maintenance cost small.

2. The absence of commutators allows the generating equipment to operate at high speed, cutting down the initial investment, using less floor space and adapting it to direct turbine drive.

3. Transmission at distances is easy and economical, as the voltage can be raised to practically any point desired.

4. When the power is consumed in squirrel-cage motors, the absence of commutating difficulties and exposed live parts allows the voltage applied to the motors to be raised to a point that would be unsafe with direct current. This of course does not apply to slip-ring motors.

Disadvantages:

1. The squirrel-cage motor is inherently a constant-speed device, its starting torque is low, and its power factor when operating at less than full load is so low that an enormous waste of power is entailed in the use of motors large enough to start heavy machinery, which may take the full power of the motor when starting, but which may impose only a 25 or 50 per cent load after the running condition is reached.

2. The slip-ring wound-rotor motor, which offers the only alternative to the limited operating characteristics of the squirrel-cage motor, introduces all the objections of the direct-current commutator, and the correction is only partial.

3. Unless transformer stations are to be installed at all places where large motor loads are concentrated, the fact that all three conductors of a three-phase system must be run in the same conduit or cable limits the size of individual feeders within a plant and raises the cost of the distributing system to the point where it neutralizes or even overbalances the saving due to the lower cost of the other alternating-current equipment.

4. Great care must be used in designing an electrical installation where alternating-current is used for power and light, to keep away from interference between the 60-cycle power and light wires and the telephone and signal wires, due to induction.

5. Aside from being fixed by the design of the machine, induction-motor speeds are subject to a limitation due to the speed being a direct function of the frequency used, which entails difficulties even in the case of constant-speed drives, where direct connection is desirable.

Direct-Current Advantages:

1. The direct-current motor can be designed for any speed desired and to give practically any relation between starting and running torque that may be required.

2. Even in cases where it is desirable to overmotor a drive in order to provide capacity to take care of occasional normal or unusual overload conditions, the penalty in lowered efficiency in the normal underload condition resulting is almost negligible.

3. In addition to the advantages offered by the possibility of designing to any speed desired, it is possible, after installation, to raise the speed from 15 to 100 per cent by the addition of an inexpensive fixed or adjustable field resistor.

4. The direct-current cables may be run in separate conduits or lead sheaths without introducing any induc-

tive troubles, so that by using large single cables in multiple, single feeders can be built up to carry any amount of power desirable.

5. Freedom from inductive troubles allows the power and light cables to be run as close to the signal and telephone cables as it is desirable or as the Code will allow, without interference.

Disadvantages:

1. The direct-current motor is somewhat more costly (horsepower for horsepower) than the alternating-current machine and has more breakable parts to require replacement and maintenance.

2. Transmission at great distances is impracticable, owing to the inability to raise and lower the voltage at will through static transformation.

3. The voltage that can be applied with safety to a direct-current motor is lower than that which can be applied to an alternating-current motor (squirrel-cage) owing to the exposed live metal parts and to commutation difficulties.

4. Generating equipment must be operated at a comparatively low speed because of commutation difficulties.

In plants where the machinery is all of such a nature that it takes but little more power in starting than in running and where practically everything can be run at constant speed, there is little to be said in favor of direct-current operation, as the simplicity and low first cost of the alternating-current equipment give it an almost overwhelming advantage. So, also, in the case of central-station service the greater adaptability of the direct-current system for use in the numerous types of plants served by a single station can be lost sight of when the transmission possibilities and the advantages of high-speed direct-connected turbo-alternator generation are taken into consideration.

The plant under consideration presents an almost perfect example of the type of manufactory where the common mistake of "following the leader" will inevitably result in the building up of an expensive installation of misfit equipment. As a matter of fact, an inspection of existing sugar-refining plants will result, in most cases, in a wonderfully complete education in the science of how not to apply power.

Analysis of Conditions

An examination of the conditions surrounding the power layout for a sugar refinery will result in some such analysis as the following:

1. The typical refinery, as it has developed over a long period of years, consists of a number of closely grouped or physically connected buildings so arranged that, while there is a definite line of demarcation between the processes carried on in each building, the movement of raw and partly manufactured material from building to building and from floor to floor within buildings is practically continuous. In a well-designed plant the amount of storage capacity for the various intermediate products is (and can be, by virtue of the design) kept to a minimum.

2. As centrally located as possible in the building group are a power plant and a boiler plant having approximately twice the steam capacity required by the prime movers, the excess steam being required in the processes and being used directly for heating purposes.

3. The sugar starts in the raw state from the point of receipt, usually on the water front, and is delivered in the finished and packed state at the shipping point, usually a railroad spur, the movement taking place as nearly as possible through a continuous sequence of processes and without inter-process delays.

4. Throughout the entire process movement, from the time that the raw sugar is dumped from the original bags and melted or mingled with syrup until it assumes the dry, granular state in which it reaches the market, both the sugar and its byproducts are handled in a liquid or semi-liquid form, or in the form of granulated sugar mingled with sufficient liquor to keep it moist and sticky. In the liquid and semi-liquid forms it is handled at a temperature of from 100 to 180 deg. F., and if it is allowed to stand for any considerable length of time without being worked, it either cools or dries to the point where it hardens and "freezes" the machines in which it happens to be. For this reason the power required to start almost any machine in the plant is from three to ten times that needed to keep it running after conditions have become normal for operation.

5. Nearly all the processes and groups of processes are continuous, the material being handled by a succession of pumps in the earlier stages and later by various forms of conveyors and elevators. If excessive inter-process time and tank or bin capacity are to be avoided, it is necessary that the speeds of the various conveying media be capable of close adjustment, so that each may be run in such a manner as to take away all the material supplied to it by its predecessor in the process, and at the same time not move the material through the processes at an excessive rate of speed.

Variable-Speed Drives Essential

As a preliminary to the decision as to the type of power to be supplied to the Baltimore Refinery a careful analysis was made of all the drives in the proposed layout. After extended consideration and the elimination of all questionable items, this analysis showed that, of the aggregate of approximately 8,000 horsepower connected motor load, in the case of the drives making up more than 80 per cent of the total, either a speed adjustment was absolutely necessary or a distinct advantage was to be gained by providing means for obtaining an adjustment.

In almost as great a percentage of the drives the nature of the machines driven and of the products handled was such that the starting torque was so high as to require excessive overmotoring of drives if squirrel-cage motors were to be used.

The close concentration of the motors constituting the heaviest connected loads, which in most cases operate on short, overlapping cycles, indicated that a great advantage was to be gained by serving as many motors as possible from a single feeder in order to take advantage of the lower diversity factor and to decrease the amount of copper required for the distribution system. The use of direct current lent itself admirably to this, as heavy cables (the largest of 1,500,000 cm. section) could be installed in separated ducts, and even used in multiple to form single heavy feeders. Circuits of similar capacity in an alternating-current installation would have required three wire cables so heavy as to present a difficult and costly problem of installation.

No more than a glance at the foregoing is required to indicate plainly that the advantages to be gained in process and mechanical efficiency are so great as to more than overbalance the slight disadvantages due to bulkier

generating equipment, slightly higher first cost of parts of the equipment, and higher maintenance.

There is little doubt that, were the same thorough methods of analysis applied in all cases of industrial power projects and proper weight given to considerations of process efficiency as against power-generating convenience and efficiency, the development of direct-current generating equipment would in a short time reach the point where direct-connected turbine-driven units could be procured in the larger capacities which would be entirely as satisfactory as the turbo-alternators.

Aside from the use of direct-current the feature of the new refinery's power installation that has caused the most discussion is the use of reciprocating engines for prime movers.

As will be seen later, after the decision in favor of direct current, the reciprocating-engine decision was almost forced upon the designers, although there were other contributing factors, and it is doubtful whether turbines would have been installed even had the electrical situation been otherwise.

Conditions That Influenced Selection of Prime Movers

Examining the problem from the viewpoint of the prime movers alone and entirely aside from the type of generators which they were to drive, the following facts were available:

1. A turbine of standard manufacture, which was installed in a certain similar plant, had begun operation with a water rate (operating non-condensing) of about 30 lb. per kw.-hr. Within a comparatively short time the water rate was found to be 50 lb. and it later rose to something over 60 lb. Upon examination it was found that the casing was cut out around the blades and that the blades were badly worn, in some cases being nearly cut through. It was rebladed, which brought the water rate down to approximately 40 lb., but when the unit was put into operation the rate immediately began to rise and finally went to 70 lb. per kw.-hr. At this point the manufacturers were again called in and decided that the only hope of saving the machine was to install a bronze liner in the casing and to attempt to design a blade of a material that would stand up under the conditions. It was suggested that the use of superheated steam would cure the trouble, but examination proved the steam at the throttle to be reasonably dry.

It was found that the feed water was decidedly acid in reaction and that a large amount of compound was being introduced to overcome this condition. This seemed to indicate one of two things—either the acidity was so great that the blades were actually being eaten away by the chemical action, or else sufficient of the boiler compound was going over with the steam to cause erosion. The acidity was finally blamed as the direct cause of the trouble, but was looked upon at the time as being a local condition and not due to the refining processes. At about this time a turbine in another refinery began to give trouble in the same manner, though not to so marked an extent.

In 1920 a delegation of engineers was sent to Europe to study conditions in refineries there. They brought back the report that the reciprocating engine was used almost to the exclusion of the turbine in refineries abroad, and that the use of turbines had been stopped owing to the same troubles that had been experienced here.

Turbine Blading Troubles Due to Feed-Water Conditions

An explanation was finally arrived at which seemed to carry some elements of probability. It has always been a problem in refineries to keep sugar out of the water which is returned from the process heating points to the boilers. A large part of the steam used is expended in closed-coil heaters immersed directly in the sugar solutions in boiling pans and heating tanks. The development of a slight leak in any of the coils allows the sugar to get in, and it is carried through the traps and finally returned to the feed-water heaters.

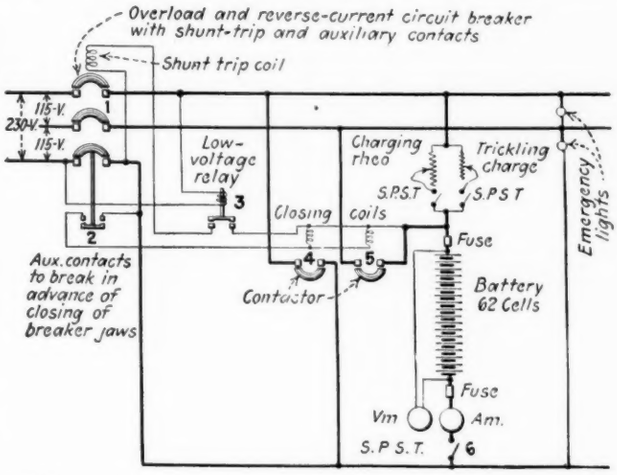


FIG. 4—DIAGRAM OF CONNECTION FOR EMERGENCY LIGHTING BATTERY

In order to keep down the trouble, sampling lines are carried from all steam coils to a central point where a continuous sample is taken and periodically tested for the presence of sugar. By keeping a close watch of the test results, leaks are usually caught and repaired before they develop to a serious point.

It is known that sugar, under the influence of heat, breaks down and forms certain complex organic acids. It is believed that these acids or in some cases the excessive amount of boiler compound which is introduced to neutralize them are the cause of the trouble. While the sampling and testing method of control takes care of the large leaks, a certain amount of sugar gets into the return water before they are discovered and remedied, and it would be almost impossible to eliminate the trouble completely so long as the drips are to be returned to the boilers.

Before any great amount of time had been spent upon the turbine-reciprocating engine question, the determination to use direct current in the plant had been arrived at, and this altered the basis upon which the decision had to be made.

High-Speed Direct-Current Units of Large Capacity Not Available

Up to this time no one (in this country, at least) has built a 240-volt direct-current generator suitable for direct connection to a high-speed turbine, in a capacity larger than about 750-kw. The nearest approach to this class of machine of which anything could

be learned was a 750-kw. 240-volt d.-c. machine, operating at 1,800 r.p.m. This machine, so far as could be learned, was operating satisfactorily. However, a unit of the size desired for the new plant required a new design, involving several new and untried features.

One manufacturer had complete designs at the time for a machine of satisfactory capacity, and had complete confidence in their ability to build it successfully, but it was felt that there was too much at stake to allow of experimenting with untried machines. No other manufacturer was in a position even to submit designs on such machines.

This left as alternatives only the reciprocating engine and the geared turbine drive. It required little discussion to decide that the former, a sturdy, tried piece of equipment, with long life and satisfactory operating characteristics, was the logical and proper solution of the problem.

What the effect of a more elaborate investigation into the effects of the sugar acids on turbines would have been had the question of direct-current generation not entered is a matter for speculation. It is probable, however, that the result would have been the same, for the presence and source of the acid having been established and the damage to the machines definitely laid at its door, it is likely that corrective measures would have proved too difficult and costly to warrant their adoption.

The Baltimore Power Plant.

Fig. 1 shows a view of the generating floor of the power plant, with the generator units, balancer sets and control and lighting switchboard. This switchboard carries only the lighting circuit breakers and bus and the control equipment and instruments for the power-feeder and generator circuits.

The power-feeder circuit breakers and bus structure are all located on the first floor of the building. All power-circuit breakers are of the motor or solenoid operated, remote-controlled type, operated from the switchboard shown.

Each of the two balancer sets that appear in the photograph consists of two 115-volt 25-kw. Ridgway machines, compound wound with the shunt fields cross-connected within the sets, and furnish the neutral for the three-wire 115-230-volt lighting system.

Fig. 2 shows a closer view of the control and lighting switchboard.

Fig. 3 shows the main bus and circuit breaker structures on the first floor of the plant. The circuit breakers throughout the plant are the Cutter Company's I-T-E machines, designed for a maximum temperature rise of 20 deg. The generator breakers are 8,000-ampere motor-operated machines, each with a 2,000-ampere equalizer arm mounted between the two main poles. The generator leads, each built up of ¼ x 8 in. copper bars, pass down from the generator connections through tunnels in the generator foundations, directly to the circuit-breaker studs. This location and construction of the generator breakers is one of the salient points of the electrical design, shortening, as it does, the electrically unprotected section of the generator leads and giving to the necessarily unprotected section such mechanical protection that accidental connection and the resulting short-circuiting of the leads and generators is a practical impossibility. The incorporation of the equalizer switch with the generator breaker makes impossible the throwing of an incoming machine onto the bus without equalizer connection, with the accompanying disturbance or shutdown. The breakers are provided with overload, no-voltage and reverse current trip, time limit, and non-closable on overload features, which guard against careless operation, local failure of steam connections and momentary disturbances that might otherwise shut down the plant.

The main power bus is built up of ¼ x 8 in. bars mounted on standard G.E. bus supports between the two rows of circuit breakers, which are placed back to back, with an operating aisle on each side and an ample working aisle between. Connection from the generator breakers to the bus is overhead, of the same dimensions as the leads from the machines to the breakers. No disconnecting switches are used in the generator leads, but complete segregation of the breakers can be achieved by removing the ammeter shunt from one side and a removable section of the bus from the other. The use of bolted connections makes this a simple matter, as the shunts and removable sections are installed over the operating aisles in an easily accessible position. All bus connections are bolted, rather than clamped, and laminated studs are used on all the larger breakers.

Each of the power feeder breakers is mounted on a 2-in. slate panel and is provided with overload and direct-acting inverse time-limit features. Permanently attached operating handles are provided on all these breakers for use in the remote contingency of the failure of power to the control bus. Connections from bus to breakers are made from overhead through disconnecting switches of suitable size, mounted on separate Monson slate panels. These disconnects are installed without locking devices, as it was felt that the stresses under any possible condition would be insufficient to open them. This decision has been amply justified in the short time the plant has been in operation, as in two cases of practically dead short circuit on the heaviest feeders, the disconnects have stayed in. Removable sections in the main bus make possible its easy segregation into several parts in case of local trouble or repair work.

Storage Battery Used for Emergency Lighting and Circuit-Breaker Remote Control

An amply large cable pit is provided under and between the breaker structures, serving as the central terminus of the underground distribution system, and all outgoing cables drop directly into it from their points of connection at the breakers and thence out through the underground ducts to the buildings served. All are pot-headed above the floor and fireproofed within the pit with a double wrapping of asbestos tape, impregnated with sodium silicate after application.

Full provision is made for the future installation of additional feeders and breakers.

The use of remote-operated power circuit breakers and a system of emergency light through the refinery buildings made necessary the installation of a 62-cell storage battery. The emergency lights in all cases are on entirely separate circuits from the normal lights and are so arranged that they burn at all times, normally taking power from the regular lighting bus on the second floor of the power plant. In case of trouble with the normal lighting circuits, the generators, or the balancers, the emergency lighting system is thrown onto the battery and operates independently of the rest of

the system. This, and the charging of the battery are accomplished by a circuit arrangement substantially as shown in Fig. 4. Minor changes were made at the time of installation, but the general scheme remains the same.

It was desirable to serve the emergency lights normally through a three-wire system in the same manner as the normal lights. When they were thrown onto the battery, however, this would have required the use of two sets of cells, each giving about 115 volts. In order to make this unnecessary, the arrangement was made so that after being taken off the normal service, the two outside wires are connected together and act as one side of a two-wire circuit, while the neutral acts as the other side. The diagram indicates very clearly how this is brought about. During normal operation of the emergency system, the three-pole breaker 1 is closed, connecting the three-wire system back to the normal lighting bus. The battery is now connected across the outside wires through either the main charging or the trickling charge rheostat, depending upon its condition. Contactors 4 and 5 and the low-voltage relay points 3 are open. The auxiliary contactor 2 on the breaker is also open. The single pole switch 6 is closed except when the battery is to be taken entirely out of service.

Two Outside Wires of Circuit Connected as One on Battery Service

Upon failure of power supply to the normal lighting bus for any reason or the dropping of the voltage beyond a certain predetermined point, the low-voltage relay 3 closes, operating the shunt trip on the main breaker 1, which opens. In opening, the breaker closes the auxiliary contact 2, which establishes the circuit through the closing coils of the contactors 4 and 5, which immediately close. The closing of 4 connects the two outside wires of the three-wire circuit together, and the closing of 5 connects the battery to what was formerly the neutral wire of the three-wire circuit, but which has now become one of the wires of a two-wire circuit. This completes the operation, and we now have the battery connected across the two-wire system, with the regular three-wire source of power cut off. The auxiliary contact on the breaker is so arranged as to open before the breaker arms establish contact in closing, as otherwise a short circuit would be established through the contactor 4 upon again closing the breaker.

The battery receives a small charging current at all times through the high-resistance "trickling charge" resistor, and this trickling charge is approximately sufficient to make up for the power used under normal operating conditions for signal light operations and the operation of the breakers. Periodically, as necessary, the main charging resistor is put in parallel with it and the battery receives a boosting charge sufficient to keep it in condition.

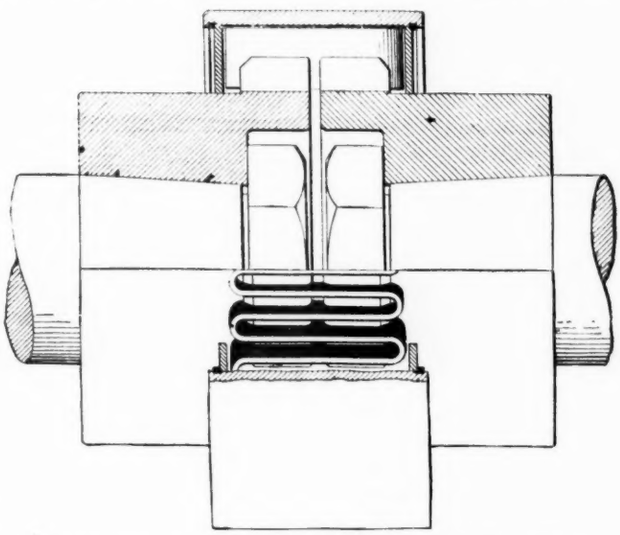
Aside from the points mentioned, the power plant presents no features not in general use. It has been in operation for approximately five months and has proved itself to be satisfactory in all details and adequate for the purpose for which it was designed.

The generating units are of special design and have some new and interesting features in valve-gear mechanism. A description of these units will appear in the Sept. 26 issue.

Spring Coupling for Oil-Engine Drive Used in England

The Port of London Authority have a number of 300-hp. semi-Diesel engines driving Rateau blowers through a 10 to 1 increase gear. The engine flywheel at 300 r.p.m. has the unavoidable cyclic speed variation of four-cylinder oil engines. In this case it is about 5 per cent. The blower at the high speed of 3,000 r.p.m. constitutes a very potential flywheel tending to run at a uniform angular velocity. In this drive two powerful flywheels are connected and one has a cyclic speed resisted by the other. The effect of this condition is to produce in the intervening mechanism very high torsional stresses at the rate of about 10 per second.

These rapid alterations of torque were found to be very destructive of the gearing and broke several couplings. The cost of upkeep of the plant became prohibitive and it was about to be abandoned when a coupling of new design was fixed between the engine and the gear box and another between the gear box and



FLEXIBLE SPRING COUPLING USED WITH SEMI-DIESEL ENGINE

the blower. The result was that the periodic impulses were absorbed and the plant was converted to a smooth-running and reliable one.

In this coupling, developed by an English manufacturer, a spring transmits the torque from one shaft to the other and the effective working length of the spring varies inversely as the load. In form the spring is sinuous and is arranged in axial grooves around the circumferences of the coupling flanges. These grooves form a snug fit for the spring at their outside ends, but gradually flare out toward one another. The entire length of each section of the spring is free to bend and will accommodate any lack of alignment in the shafts when only a small torque is being transmitted. As the load increases, the spring bears against the side of the groove, the span of the unsupported section is reduced and it is claimed that this makes it easier to withstand flexure. The flexibility of the coupling is automatically adjusted to the load. It is claimed that these couplings have been used in transmitting as much as sixteen thousand horsepower required in a rolling mill running at 100 r.p.m.

The Draft Over the Fire

The Importance of Maintaining a Constant Low Draft Over the Fire in the Case of Boilers Operating Under Forced Draft

By E. M. ELIOT

A WELL-KNOWN writer on power plants in a recent series of important articles, discusses all phases of combustion, including methods of increasing CO_2 percentage in flue gases, and leaves the impression that, after forced draft has been properly provided for, the thickness of the fuel bed made correct and uniform, and the boiler setting made tight, all will be well and boiler efficiency will more or less take care of itself as far as draft is concerned. The facts are, however, that while theoretically all this is correct, fuel beds do not stay of the correct thickness, holes will develop in the fire in spite of care, and boiler settings leak air notwithstanding every precaution.

Under these practical conditions, if thought has not been given to the draft over the fire, excess air will enter, temperatures will fall or rise unduly, and a series of ills will appear, beginning with insufficient stack capacity and ending with cracked and burned-out boiler linings.

Measurement of the percentage of CO_2 in the flue gases is the watchman against these conditions, and manual or automatic adjustment of the boiler damper or induced-draft fan is the most efficient remedy. The percentage of CO_2 in the flue gases is generally recognized as an indicator of the effectiveness of combustion and the amount of excess air going through the boiler, but when it comes to the remedy, each man "gangs his ain gait."

One engineer advocates rigid inspection of the boiler settings and expensive maintenance of them and will listen to nothing else; overlooking the fact that, human nature being what it is, he is asking something that is pretty nearly impossible of accomplishment. Another admits the necessity of using the damper, but feels sure that adjustment once or twice a day is enough. A third operates all but one of his boilers on a constant load and constant damper position. He takes all the fluctuations of load on one boiler and adjusts the damper to the load on that boiler. The reason for so many different remedies lies in the lack of complete understanding of the facts, rather than in differing boiler conditions.

When air is introduced into a fuel bed by forced draft, the pressure under the fire is adjusted to correspond to the load on the boiler and the quantity of coal to be burned. This may be done by an automatic regulator or by hand; the result is the same. A heavy load requires more fuel and higher pressure than a light one, and pressure in the air chamber may range from 1 to 4 in. of water, according to circumstances.

If the boiler damper is left in a fixed position, or the induced-draft fan is operated at constant speed, without a damper, the draft over the fire will vary irregularly, depending on the pressure in the air chamber and the thickness of the fuel bed.

It is possible that the fuel bed may become thin when the forced draft is high, so that there results a plus pressure over the fire instead of a suction draft. That is, the forced-draft fan not only may have caused a pressure above atmospheric in the air chamber, but may have transferred some of that pressure through the fuel bed so strongly that there is pressure in the combustion chamber over the fire. In that case the fire may be forced out of the doors and peep holes of the boiler, but what is worse, the highest-temperature gases are forced against the brickwork of the boiler and into all the low-temperature pockets, where sampling tubes and mechanical soot blowers are installed. The effect is usually destructive to the boiler if long continued.

If the damper is left in one position and the fuel bed grows thick at a time when the forced draft in the air chamber is low, the natural draft of the smokestack becomes effective above the fire and may go to some such figure as 0.5 in. or even 0.8 in. of water, that is, there will be a strong suction tending to pull in excess air through the boiler setting, around doors and through every other neglected opening. None of them are passed by.

In the majority of reasonably well-managed American plants the excess air is about 100 per cent and the CO_2 in the flue gases corresponding will be about 9 per cent. These figures are approximate, but indicate roughly the conditions. This is 60 per cent more excess air than the 40 per cent usually allowed and 3 per cent to 4 per cent lower CO_2 percentage than can be carried readily with good results. Besides the loss due to heating a large amount of excess air, there will be a further loss due to the lowered temperature of the gases in the boiler. Absorption of heat by boiler tubes will be less and the flue-gas temperature consequently higher than when there is less excess air to absorb the heat of the fuel.

Draft conditions over the fire, in the ordinary plant using forced draft, will vary between the extremes described from hour to hour and even from minute to minute, as the load on the boiler changes, as the fuel bed changes, or as the boiler attendant adjusts the air supply and fuel feed. The only exceptions to this are boilers under constant load, with such type of fuel feed that there can be no change in the thickness of the fire. These exceptions are rare and are not considered in this article.

There can be only one best condition. The problem

HERE is much food for thought—the kind of thought that can be quickly translated into dollars and cents. The subject of draft is a tricky one in which first hunches are likely to be wrong. Many of the author's statements are in direct contradiction to the opinions of the average operating engineer, yet they are presented in a manner easy to follow and backed up by convincing logic. In an early issue a second article by the same author will show how to put this knowledge into practice.

of each plant is to find out what that best condition is, notice whether it changes with changing load, and either change it accordingly or effect a satisfactory compromise between extremes.

There is one misconception that should be disposed of before going farther; that is the belief held by many engineers that a change in draft over the fire, in itself, changes the velocity of the gases through the boiler. This is not a fact, as can be demonstrated.

Velocity Little Affected by Draft

Consider the boiler at any instant as a closed vessel. Then, for a given weight of gas,

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

where P_1 represents the absolute pressure, V_1 the volume and T_1 the absolute temperature in a boiler having a draft over the fire of 0.05 in. In the same boiler let P_2, V_2 and T_2 represent the corresponding quantities for a draft of, say, 0.8 in.

If excess air is not considered (supposing the boiler setting is tight), T_1 practically equals T_2 and $P_1 =$ 407.35 in. of water; $P_2 =$ 406.6 in. of water; using 407.40 in. of water as atmospheric pressure. From this,

$$V_2 = V_1 \times \frac{407.35}{406.6} = 1.0018 \times V_1$$

Since the draft drop through the fuel bed and the areas of the boiler passages, except possibly that of the damper, remain unchanged, and the total volume is changed only 0.2 of 1 per cent; also since velocity equals volume per second divided by area, it is clear that the change in velocity of gases, at any point of the boiler, is less than 1 per cent for any difference of draft over the fire that is likely to occur. There is, then, no ground for stating that a particular draft, in itself, appreciably affects the velocity of the gases in the boiler.

Air Leakage and Velocity

A condition under which the velocity of the gases is actually reduced occurs when there is excess air at high draft and this is reduced by a change to low draft. Under these circumstances the volume of gases is reduced by the amount of the reduction in excess air, and the velocity of the gases is decreased, since the areas of the boiler passages remain the same. If the reduction of excess air is advisable, as is ordinarily the case where there are no very high overloads, this reduction in velocity is also beneficial. The reduction in velocity causes the hot gases to remain longer against the boiler tubes, thus increasing absorption of heat by the boiler and lowering the flue-gas temperature.

Excess Air at Overloads

High draft may be needed at overloads to introduce excess air and keep down the temperature of the boiler setting, but never of itself produces high velocity of the gases except by introduction of excess air, which uses the heat of the coal and wastes it. As for high velocity of gases keeping boiler tubes free from soot, the records of a prominent manufacturer of mechanical soot blowers, examined for the four years just past, do not show any instance where tubes have been kept clean by high velocity of gases.

The question of the velocity of gases in the boiler may thus be entirely omitted from the discussion of the draft over the fire. Both the ideas that draft governs velocity (except by modifying the amount of excess air) and that high velocity of gases is beneficial in itself, are erroneous.

To return to the best condition for draft over the fire, it should not be a plus pressure because of blowing the fire into the boiler room and causing undue heating of the furnace lining; it should not be a high draft because excess air will enter the boiler. It should be high enough to remove the gases as fast as they rise from the fuel bed and high enough so that extreme temperature does not fill every pocket in the boiler setting. Carefully made temperature charts of boilers in operation show amazing differences in temperature of adjacent surfaces. Pockets, or places of low temperature, occur in the setting if the flow of gases through the boiler is continuous, and these are used to install mechanical soot blowers, sampling tubes and other devices which must be protected against the highest temperatures. Otherwise the draft should be as low as possible to avoid introduction of excess air. Experience shows this to be a draft of between 0.05 and 0.08 in. of water, except in the case of poorly designed furnaces, when it may be somewhat higher.

Settings Are Rarely Tight

Some engineers say, "Why go to a lot of trouble to keep the draft at exactly 0.05 in. or thereabouts, when by keeping the boiler setting tight, you can let the draft be anything convenient."

There are two good reasons for keeping the draft low. In the first place, anyone who has tried to make a boiler setting tight and keep it that way, knows it is a difficult thing to do in actual practice. Money is not always available for keeping the lagging of the boiler in repair; cracks and leaks develop in out-of-the-way places; doors are seldom tight. Actual figures for 165 American plants using forced draft show that the average draft over the fire is 0.3 in. of water. With such suction the boiler will seldom be kept tight, notwithstanding an executive's severest injunctions.

Average CO_2 Around Nine Per Cent

Probably more than 80 per cent of American boiler settings leak appreciably. The quantity of excess air that it is best to allow under practical conditions is 40 per cent, but the majority of reasonably well-managed American plants have about 100 per cent excess air in the boilers. This figure, which corresponds to 9 per cent CO_2, is the result of extended observation.

The second reason for not permitting the draft to swing from one extreme to the other, without control, is that plus pressure is pretty sure to develop over the fire at times, and this is detrimental to the boiler and causes dissatisfaction among firemen, due to "burns" and smoke in the boiler room.

The objection is also made that a high draft is needed at extreme overloads, and sometimes this is true. The only reason for such increase, however, is the holding down of the temperature of the gases, by permitting excess air to enter the boiler, and thus preventing burning out of the boiler lining. The condition is an uneconomical one and should be avoided as much as possible. At the same time, it must be recognized that there are cases where economy must be sacrificed to life of equipment.

Reductions of excess air, due to low draft, mean greater chimney capacity. It is usual to lower the excess air to about 40 per cent, when proper means

are employed for keeping the draft over the fire constant at about 0.05 in. The expression for increase in chimney capacity is then

$$\text{Per cent increase} = \frac{\text{per cent excess air} - 40}{140}$$

With excess air at 100 per cent to begin with, increase in chimney capacity equals (100 — 40) ÷ 140 = 43 per cent. If the CO_2 in the flue gases is less than 9 per cent, draft control will give more than 40 per cent increase in chimney capacity.

The practical effect of this is far-reaching. Especially at the present time there are many plants that should have one or more additional boilers, but whose owners hesitate to go ahead with these additions because the chimneys for such plants are already fully loaded. A practical increase in stack capacity of 40 per cent to 60 per cent by arranging for constant low draft and elimination of excess air on all boilers, may permit the additional boilers to be installed without requiring additional chimney capacity.

Still further, if the overload that can be carried is limited by the amount of draft that can be obtained at the damper (and excess air is not required to keep down temperature), the draft at the damper may be increased and the overload carried by lowering the draft over the fire, and thus reducing the excess air that the chimney must carry. It should be noticed that these facts are diametrically opposite to the erroneous impressions some engineers hold concerning the value of a high draft over the fire, in carrying overloads.

Important to Hold Draft Constant

The best condition being established (usually at about 0.05 in. of water) the next question is whether it is important to keep it constant. Of course, if a best condition has been discovered it should not be changed; but aside from this, low constant draft means constant low excess air. Constant low excess air means high constant boiler temperature, because heat is not being wasted on dead weight of air and there is no fluctuation of the amount of excess air to cause changes in the temperature of the gases. When the draft fluctuates, however, there is, first, a loss in heat absorption by the boiler tubes, in addition to the loss due to excess air, and second, a wearing out of boiler tubes and settings, due to continual changing of temperature inside the boiler. These conditions are true for all normal loads, therefore the draft over the fire should ordinarily be kept constant.

It may be well to digress at this point, to explain why constant high temperatures are desirable under normal load and low draft, whereas high temperatures at overload must be guarded against, and even moderately high temperatures, with a plus pressure over the fire, may be seriously detrimental to the boiler. A boiler is most efficient, other things being equal, when the temperature of the gases is the highest possible without causing too great deterioration of the setting. Under normal load and draft it is usually safe to push the temperatures up as high as they can possibly be made to go. However, under heavy overloads, 250 per cent or over, the temperatures may rise so high as to be unsafe for the boiler lining, therefore this condition must be watched at high overloads.

With plus pressure the difficulty is not with the amount of the temperature, but with its distribution. The plus pressure tends to crowd the highest-temperature gases against the boiler setting, owing to the porosity of the setting, or small leaks in the brickwork, and into all protection pockets, instead of keeping them in the center of the boiler passes where they belong. Thus soot blowers or instrument taps may be ruined, or the setting burned, by temperatures which ordinarily would do no harm because of their distance from the setting of the boiler.

Advantages of Constant Low Draft Over the Fire

Summing up, it appears that a constant low draft over the fire accomplishes the following things, listed in the order of their importance:

1. Reduces excess air by decreasing the suction or draft within the boiler.
2. Increases temperature of gases and keeps this steady, resulting in greater absorption of heat by boiler tubes.
3. Prevents sudden and frequent changes in temperature of gases, resulting in fewer contraction and expansion strains in boiler and brickwork.
4. Prevents plus pressure over the fire, resulting in less burning of boiler lining and auxiliary apparatus, thus increasing their life.
5. Increases percentage of CO_2 in the flue gases as a result of item No. 1.
6. Increases stack capacity as a result of item No. 1.
7. Decreases temperature of flue gases as a result of item No. 2.
8. Change of load does not change the essential conditions or make a low draft less desirable, except in cases of heavy overload, when a constant draft, somewhat higher than that needed for ordinary conditions, is sometimes required to keep down excessive temperature.

A tight boiler setting will do all these things except prevent plus pressure, but to begin with, it is hard to obtain and still harder to maintain after once established.

Having established the case for a constant low draft over the fire, the next part of the problem is to find effective and economical means of obtaining it, with suitable means for modifying it should this become necessary. A second article will cover this question.

While the desirable governor for an oil engine must not be sluggish, it does not follow that a sensitive governor will hold the engine speed within narrow limits on a change from no load to full load unless a correct design of pump is chosen. Much depends upon the effort which must be exerted on the fuel pump mechanism to bring it from its minimum pumping position to its maximum position. Since a large change in engine speed gives the governor a maximum force to exert on the pump, it follows that the greatest permissible fluctuation in engine speed should be adopted to give the governor a high work capacity. A 6 per cent fluctuation or 3 per cent variation above or below normal speed is quite satisfactory for oil-engine governing. It does not follow that this variation occurs on any save extreme load changes. In the load changes that ordinarily take place, the fluctuations would not exceed 1 per cent, since the governor-sleeve travel is small on small load changes.

Since the moisture in coal always passes up the stack as a vapor, it causes a loss of about 1,000 B.t.u. per pound of moisture. For average coals this loss is less than 1 per cent of the heat in the coal.

Evaporators in the Stationary Power Plant*

AFTER a short review of the elementary principles this article takes up the high-pressure and low-pressure systems, describing the apparatus and showing how the layout is determined by the heat balance of the particular plant

AN ARTICLE in the Feb. 21, 1922, issue of *Power* told, in as simple a manner as possible, what an evaporator is and how it works. Before taking up the application of evaporators to stationary power plants, the main points previously brought out will be briefly reviewed.

The term "evaporator," as here used, refers to a piece of apparatus using steam to distill raw makeup water for boiler feed. The chief purpose of the evaporator is to eliminate the evils of boiler scale, not by removing the scale after it is formed, or by chemical treatment of the scale-forming impurities, but by furnishing distilled makeup practically free from all dissolved solids, scale forming or otherwise. It must be remembered, in this connection, that even where the dissolved solids are of such a nature that they do not form scale, they may still cause priming with a resulting reduction in boiler capacity. It is true that, if the concentration of solids in the feed water is not too high, the concentration in the boiler may be kept below the priming point by blowing down a certain percentage of the total feed, the amount depending on the feed concentration and the type and duty of the boilers. On the other hand, blowdown introduces a heat loss whose amount depends on the temperature and amount of the blowdown.

The so-called "single-effect," or single-stage, evaporator is fundamentally the same as a closed heater or surface condenser in that it is a shell containing straight or curved tubes with steam on one side and water on the other.

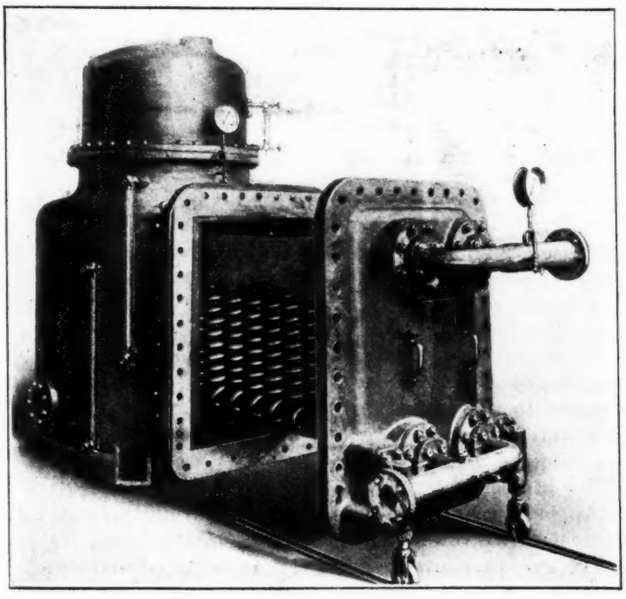


FIG. 1—SELF-SCALING HIGH-PRESSURE EVAPORATOR WITH CAST-IRON SHELL

The steam must be at a higher pressure than the water, so that the latter will be boiled away or distilled and the former condensed. The distilled vapor is carried away from the evaporator and condensed in various ways (to be described later) as practically pure water for boiler makeup. The impurities are left in the evaporator.

It is almost invariably the case that evaporators are built to take the steam within the tubes and the raw water outside. This is done to permit easy removal of the impurities. Some of these are left on the tubes as scale that has to be cracked off, and some as a sludge at the bottom of the evaporator shell. This sludge, along with the cracked-off scale, is removed by blowing down, either intermittently or continuously, a certain fraction of the raw water fed to the evaporator.

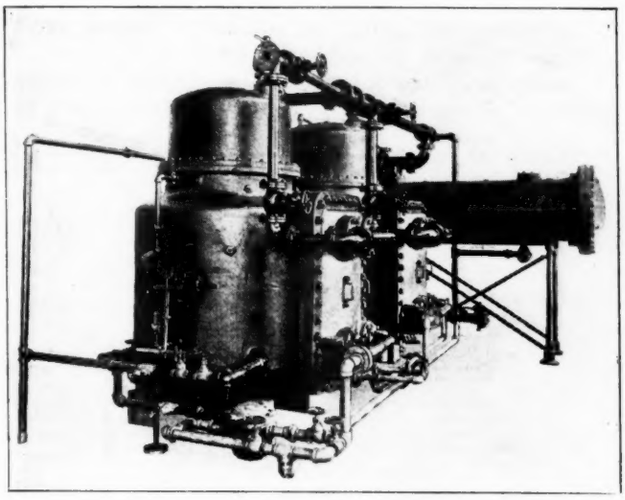


FIG. 2—DOUBLE-EFFECT HIGH-PRESSURE INSTALLATION DESIGNED FOR HIGH-HEAT-LEVEL OPERATION

If the latent heat of steam were the same for all pressures and if the heat of the liquid, as well as the losses due to blowdown and radiation, could be neglected, a pound of steam condensing would evaporate one pound of raw water in a single-effect evaporator. The amount of distilled makeup that an actual single-effect evaporator can produce per pound of steam varies somewhat with the conditions, but averages around 0.8 lb.

Under certain conditions it is worth while to make an additional expenditure for apparatus in order to obtain more distilled makeup per pound of steam used. This can always be done by employing a multiple-effect evaporator in which two or more evaporator bodies are placed in series, so that the vapor produced in one stage or "effect" passes to the steam side of the next, and evaporates there some more raw water upon condensing. The more effects there are, the greater is the amount of makeup produced per pound of steam. On the basis of the rough assumptions made for the single-effect evaporator, the figure would be 2 lb. for a double-effect evaporator, 3 lb. for a triple-effect and

*This is the second of a series dealing with feed-water treatment. The Lillie evaporator, being the subject of an early article, is not described here. The next article will discuss corrosion prevention.

so on. Actual operating results, while subject to considerable variation, will average around 1.5 lb. for a double effect and 2 lb. for a triple effect. In any case the makeup produced per pound of steam will go up nearly in proportion to the number of effects used.

At the same time, the first cost increases almost in proportion to the number of effects. This is because each effect of a double-effect evaporator has only about half the capacity it would have if used alone as a single-effect evaporator. The reason is that each effect of the former has only about half the temperature difference to work with. So if a single-effect evaporator is replaced by a double-effect, each effect must be as large as the original evaporator in order to produce the same amount of makeup water. The same general relation holds for any number of effects. The result is that, even if none of the heat in the steam used could be profitably returned to the boiler, a point would be reached where the saving due to adding another effect would not warrant the additional investment.

In addition it must be remembered that a certain amount of heat (depending on the layout) can be absorbed by the feed water, so there is no thermal gain in adding effects after the steam consumption of the evaporator has been reduced to a certain point. An economically selected evaporator will ordinarily have only two or three effects in stationary practice, although more effects may occasionally be desirable.

The steam supplied to an evaporator may be at any pressure and temperature, provided only that the condenser receiving the vapor of the last effect can maintain a lower pressure. But, since the capacity (for a given tube area and a given number of effects) is practically in proportion to the over-all temperature difference, it is important to keep the latter fairly large; otherwise the investment may become prohibitive.

On the basis of initial pressures we may classify evaporators into high-pressure (using live steam) and low-pressure (using exhaust steam). The latter are also called exhaust-steam or vacuum evaporators, the name vacuum being used because the vapor leaving the last effect must be kept at a pressure below atmosphere. High-pressure evaporators may be further classified as high-heat-level and low-heat-level, these terms referring entirely to the temperature of the last-effect vapor. It is important to avoid confusing the high- and low-heat-level evaporators with high- and low-pressure evaporators. This article will adhere strictly to the general custom of using the terms high- and low-heat-level only in connection with high-pressure evaporators.

Reserving the discussing of low-pressure evaporators for the latter part of this article, we may proceed to a more detailed consideration of the high-heat-level and low-heat-level types. The last effect of low-heat-level evaporator exhausts to an open heater at a pressure a little above atmospheric, while the high-heat-level apparatus exhausts to a special closed heater or surface condenser, through which the feed water passes after leaving the main open heater, so that the temperature of the last-effect vapor is well above 212 deg. and its pressure well above atmospheric.

The choice between these two types cannot be intelligently made without a careful study of the heat-balance of the particular plant in which the evaporator is to be installed. The deciding factor is the possibility of absorbing the heat exhausted from the last effect of the evaporator without being forced thereby to waste

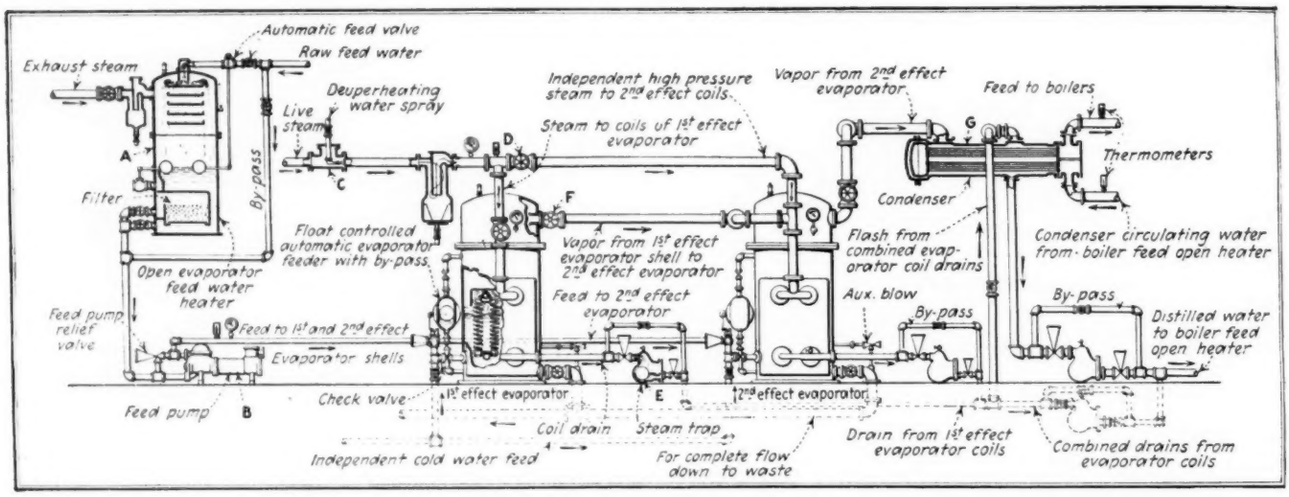


FIG. 3—ELEVATION OF THE HIGH-PRESSURE, HIGH-HEAT-LEVEL INSTALLATION SHOWN IN FIG. 2

any other supply already available. For example, the low-heat-level evaporator could not be economically used in a plant where there is an excess of exhaust steam from steam-driven auxiliaries. Since, in such a case, there is already enough exhaust steam to heat the feed water to 212 deg. in the open heater, the heat supplied to the evaporator could not be returned to the feed water except by wasting the same amount of heat in available exhaust steam.

The high-heat-level evaporator would be particularly applicable to a case like this, for it could return its exhaust heat to the boiler by heating the feed water in the region above 212 deg., because the "high-level" above 212 deg. is not available to any other sources of heat. The exception to this is found in plants that use economizers. In such cases allowance must be made for the reduction in economizer effectiveness due to the increased temperature of the feed water.

If part or all of the auxiliaries are electrically driven, as in some of the larger power plants, the available exhaust steam may not be sufficient to heat the feed water anywhere near up to 212 deg. Where the gap is sufficiently large, the feed water may be able to absorb the heat of the evaporator exhaust without going

above 212 deg. This permits the use of the low-heat-level evaporator. Sometimes the entire heat from a single-effect evaporator may be handled, but if this is too much, a double- or triple-effect evaporator, using less steam and producing correspondingly less vapor from the last effect, may fit in. The deciding factor is

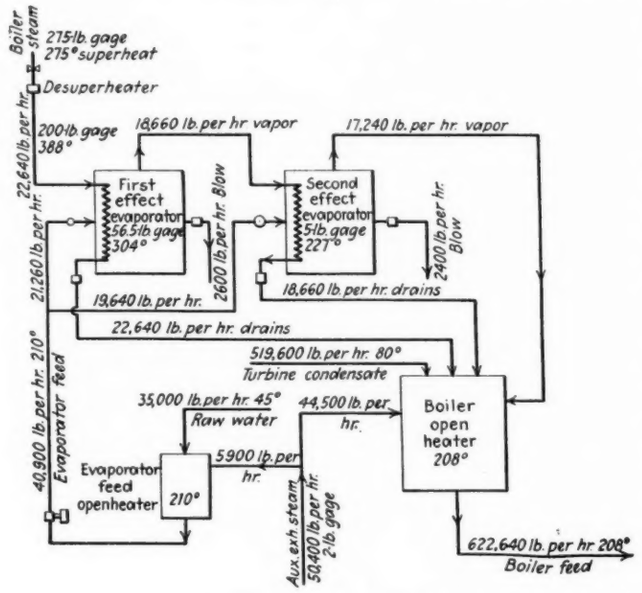


FIG. 4—TYPICAL FLOW DIAGRAM FOR A LOW-HEAT-LEVEL INSTALLATION WHERE PLANT CONDITIONS ARE AS FOLLOWS:

Net hourly boiler evaporation	600,000 lb.
Net hourly makeup	30,000 lb.
Steam conditions	275-lb. gage and 275 deg. superheat
Raw-water temperature	45 deg. F.
Hotwell temperature	80 deg. F.
Auxiliary exhaust steam per hour	50,400 lb.
Exhaust steam pressure	2-lb. gage

the ability of the feed water to absorb the heat in the level below 212 deg. The only satisfactory way to determine the proper combination is to take the fundamental data for the given plant and see how it figures out with high- and low-heat-level evaporators and with various numbers of effects.

Fig. 1 shows a typical high-pressure evaporator. This is a Reilly evaporator made by the Griscom-Russell Co. It is shown opened for inspection, the coils and their connections being mounted on a truck to facilitate this operation. A double-effect installation of the same type and make is shown in Fig. 2, which gives a good idea of the general appearance of a plant designed for high-heat-level operation. The horizontal cylinder in the background beyond the second effect is the evaporator condenser.

Referring to Fig. 3, which is an elevation of the installation pictured in Fig. 2, the operation is as follows: The raw makeup water goes first to a small open heater *A*, where it is heated by plant exhaust steam to 212 deg. This reduces the necessary evaporator surface and the amount of live steam required. It also removes a large portion of the dissolved gases and some of the temporary hardness, thus reducing the amount of scale deposited in the evaporator. The heated water then passes through the evaporator feed pump *B* to the two effects, which, as far as the water supply is concerned, are connected in parallel. Live steam, desuperheated if necessary at *C*, enters the coils of the first effect. In normal operation valve *D* is closed so that live steam does not go to the second-effect coils.

The steam condensed in the coils of the first effect is trapped back through *E* to the main open heater (not shown). The heat given up by this steam evaporates some of the water in the first effect. When this vapor passes through *F* and enters the coils of the second effect, it in turn condenses and is trapped back to the main open heater. The second-effect vapor is condensed by the main feed water (used as circulating water for the high-heat-level condenser *G*) and then passes through a trap to the main heater.

Neglecting for the moment the small amount of heat contained in the trapped condensate from the two effect and the evaporator condenser, it will be seen that the heat in the initial steam is transferred first to the first-effect vapor, then to the second-effect vapor, and finally to the feed water. All the heat supplied to the evaporator is returned to the feed water except that lost by radiation and blowdown.

In addition to blowing down the sludge left by the evaporation of the raw water, it is necessary to break off the scale that forms on the outside of the tubes. This is done at regular intervals by emptying the water from the evaporator shell and refilling with cold water, after which live steam is turned on the coils abruptly. This produces a distortion which cracks off the accumulated scale so that it can be easily removed.

Fig. 4 is a heat-flow diagram for a double-effect evaporator connected up for low-heat-level operation, while Fig. 5 is a similar diagram for a high-heat-level in-

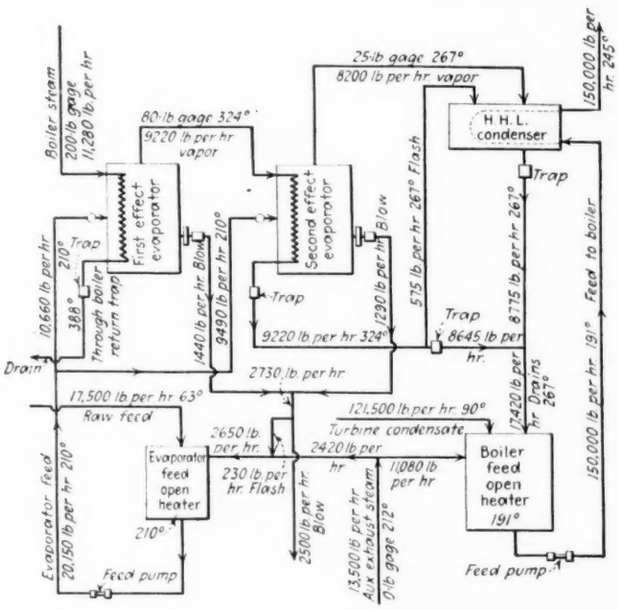


FIG. 5—TYPICAL FLOW DIAGRAM FOR A HIGH-HEAT-LEVEL INSTALLATION WHERE PLANT CONDITIONS ARE AS FOLLOWS:

Hourly boiler evaporation	150,000 lb.
Hourly makeup	15,000 lb.
Steam conditions	200-lb. gage, saturated
Raw-water conditions, 63 deg., brackish (15 per cent evaporator blowdown)	
Auxiliary exhaust steam per hour	13,500 lb.
Exhaust-steam pressure	0 lb. gage
Hotwell temperature	90 deg. F.

stallation like that shown in Figs. 2 and 3. It should be noted that the low-heat-level arrangement of Fig. 4 is feasible only where the sum of the heat in the last-effect vapor and the coil drains, plus that in the plant exhaust steam available for feed-water heating, can be absorbed by the main condensate without raising its

temperature above 212 deg. In other words, a low-heat-level evaporator should be installed only where the original feed temperature is well below 212 deg.

This margin is not necessary in the case of a low-pressure evaporator for reasons that will be given later. On the other hand, the lack of such a margin by no means prevents the economical application of the high-pressure type. It is merely necessary to oper-

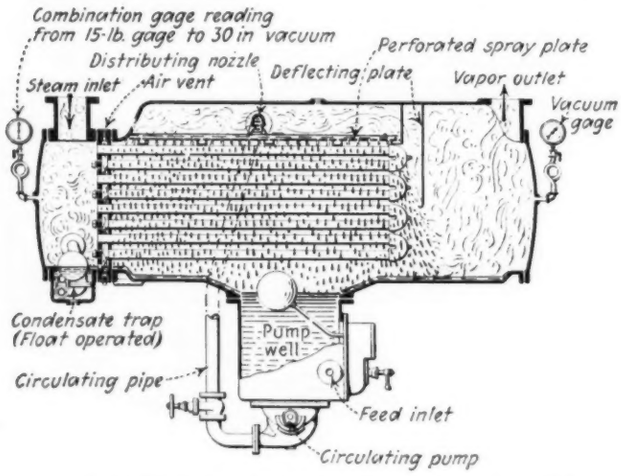


FIG. 6—FILM EVAPORATOR FOR LOW-PRESSURE OPERATION

ate the high-pressure evaporator on a high heat level. That is to say, the range above 212 deg. may be used where that below 212 is already nearly taken up by available exhaust steam. For example, the feed water in Fig. 5 is heated by the regular supply of exhaust steam to 191 deg., so the high-heat-level evaporator can continue the heating from this temperature up to 245 deg. without displacing any of the heat from the exhaust steam. Where economizers are used, there is, of course, some loss due to the fact that the economizers cannot absorb so much heat from the flue gases with the high feed temperature.

So far the discussion has been confined, in the main, to high-pressure systems. Low-pressure installations, while operating on the same general principles as far as the evaporator itself is concerned, bear a different relation to the plant heat balance. They also differ from high-pressure installations in size, design and auxiliaries, because they work under different conditions of pressure and temperature difference.

Low-pressure evaporators, as stated at the beginning of this article, are operated by exhaust steam, the pressure of which is usually close to atmospheric. To provide a sufficient over-all temperature difference for a reasonable evaporation per square foot of evaporator surface, it is necessary to maintain a considerable vacuum on the last-effect vapor. This is ordinarily accomplished by means of a small surface or jet condenser called the evaporator condenser, which is inserted ahead of the main open heater and uses the main condensate as cooling water.

Since, in a multiple-effect evaporator, the temperature drop from initial steam to last-effect vapor is divided automatically and almost equally between the effects, all parts of the system beyond the first-effect steam space are ordinarily under vacuum. This is maintained by discharging the coil-condensate traps, and also air vents on each effect, to the evaporator condenser.

Fig. 6 shows a cross-section of the Wheeler Film Evaporator designed chiefly for low-pressure operation. The water level is maintained below the lowest tubes. By means of a centrifugal pump it is continually circulated from the bottom of the shell to a perforated spray plate near the top of the shell. From this it falls down over the tubes in a thin film.

By using a double tube sheet at one end of the shell, and double tubes with return bends, it is possible to dispense with a tube sheet at one end. This simplifies the problem of inspecting and cleaning the tubes.

Fig. 7 is an erecting-shop photograph of a double-effect low-pressure evaporator where each effect is similar to that just described. The normal method of connecting a double-effect evaporator is to connect the vapor end of one effect to the steam end of the next and the vapor end of the second effect to the evaporator condenser. The particular machine shown is provided with additional vapor piping so that the order of operation may be reversed by turning a few valves. The reversing is done at regular intervals to cause a temperature change throughout the system. This prevents scale from accumulating on the evaporator tubes. The evaporator condenser shown is of the jet type and is provided with a tail pump (not shown). In addition to the second-effect vapor, the condensate from the steam space of each effect, and also an air vent from each effect, is piped to the condenser. With this arrangement the condenser tail pump discharges the main condensate (used as cooling water) as well as all the distilled water and the steam supplied to the evaporator.

Another low-pressure evaporator, the Criscom-Russell, is shown in Fig. 8. Here the bank of tubes is submerged. Steam enters the tubes at the left and is trapped off from the connection at the right. It will

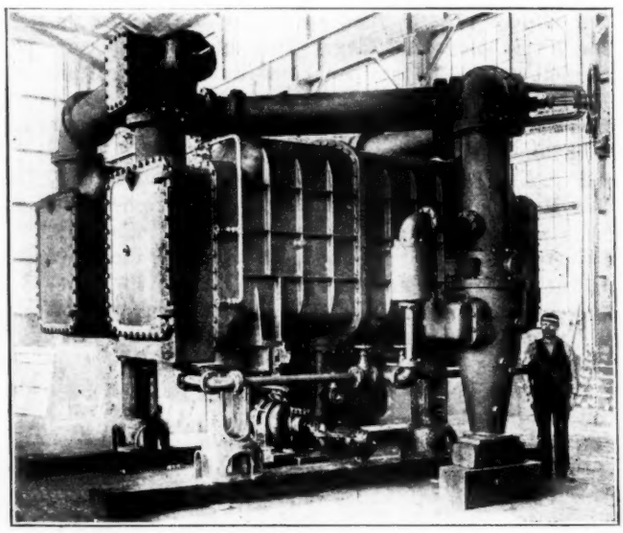


FIG. 7—DOUBLE-EFFECT, LOW-PRESSURE INSTALLATION

be noted that the tubes are bowed. This is done to insure effective scale cracking when the temperatures are abruptly changed for that purpose. To avoid priming, the vapor is taken from a dome on top of the shell.

Typical flow diagrams for low-pressure installations are shown in Figs. 9 and 10. In Fig. 9 exhaust steam, passing to the first effect, produces vapor, which goes to the steam side of the second effect. The second-effect

vapor passes to the evaporator condenser, which is here of the surface type. This condenser operates under a vacuum and preheats the main condensate before it goes to the main open heater. The condensate from the first- and second-effect coils is also trapped to the evaporator condenser.

In the layout shown raw water goes to the first effect and then to the second. This permits all the blowdown to come from the second effect where the temperature (and hence the blowdown loss) is lowest.

Fig. 10 is the same as Fig. 9 except that a jet condenser is used in place of the surface condenser. In many cases this simplifies the installation.

One of the requirements for a low-pressure system is that there be enough exhaust steam to produce the necessary makeup water with an evaporator having a reasonable number of effects. The other is that the heat exhausted from the evaporator must not raise the temperature of the condensate (and hence that of the last-effect vapor) to such a point that an abnormally large evaporator will be required.

It is important, from the investment point of view, to have the temperature of the last-effect vapor as far as possible below that of the initial steam in order to get the maximum evaporation per square foot of evaporator surface. At the same time it is obvious that the temperature of the last-effect vapor must be equal to that of the main condensate plus its temperature rise in the evaporator condenser plus a 10- to 15-deg. terminal temperature difference in the evaporator condenser.

The installation of a low-pressure evaporator makes no great change in the final temperature of the feed water. The reason is that practically all the heat in the exhaust steam gets into the feed water, either directly or through the evaporator exhaust, in any case.

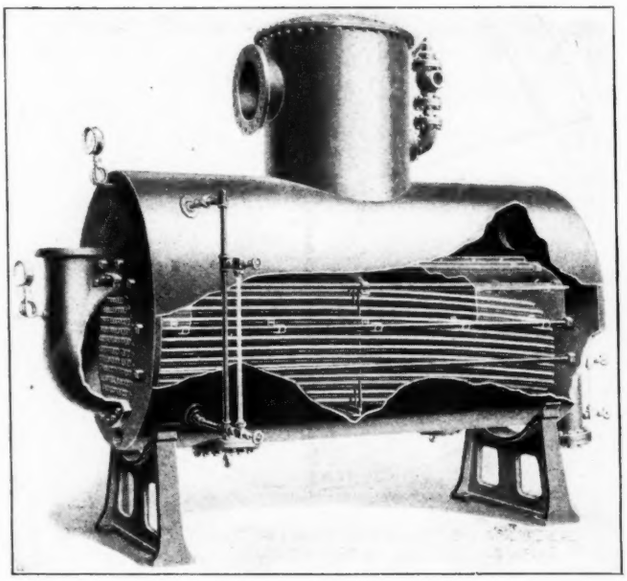


FIG. 8—"BENTUBE" EVAPORATOR FOR LOW-PRESSURE OPERATION

The proper number of effects to use is best determined by making rough heat balances using various combinations. This should be done for fractional loads as well as for full load, because the amount of exhaust steam from the auxiliaries does not vary in proportion to the amount of feed water to be heated.

The method of solving such a problem approximately is illustrated by the following example. Assume that the data for the given station are as follows:

Full load on main turbine.....6,500 kw.

Item	Full Load	Half Load
Total boiler evaporation, lb. per hr.	100,000	53,000
Main turbine condensate, lb. per hr.	90,000	45,000
Auxiliary exhaust steam, lb. per hr.	10,000	8,000
Main turbine condensate, deg. F.	85	85
Pressure of auxiliary exhaust steam, lb., gage	3	3
Distilled makeup required, lb. per hr.	5,000	4,000

To simplify the calculations, it will be assumed that each pound of vapor gives up 1,000 B.t.u. on condensing,

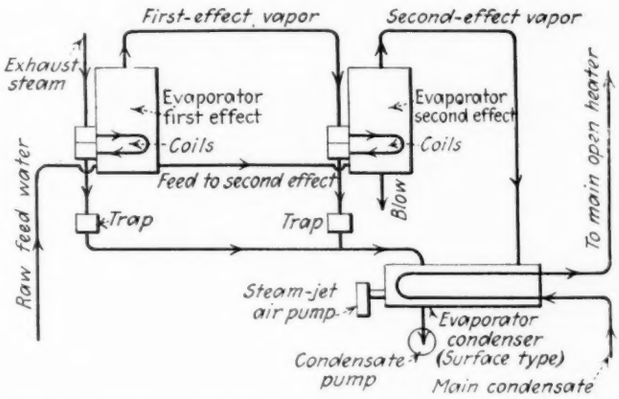


FIG. 9—TYPICAL FLOW DIAGRAM FOR LOW-PRESSURE INSTALLATION WITH EVAPORATOR CONDENSER OF THE SURFACE TYPE

and that the heat in the condensate from the coil drains is negligible.

Considering first a single-effect evaporator designed for full-load conditions, the evaporator condenser will have to handle 5,000 lb. of vapor per hour, or absorb $5{,}000 \times 1{,}000 = 5{,}000{,}000$ B.t.u. This will raise the temperature at the main condensate $5{,}000{,}000 \div 90{,}000 = 55$ deg. (approximately). If the condensate enters at 85 deg., it will leave at $85 + 55 = 140$ deg.

Allowing a 15-deg. terminal difference in the evaporator condenser, the vacuum temperature will be $140 + 15 = 155$ deg., corresponding to a vacuum of 21.5 in. of mercury. The total temperature drop from the exhaust steam entering the evaporator at 3 lb. gage (221 deg.) to the vacuum temperature of 155 deg. will be $221 - 155 = 66$ deg.

Suppose, then, that a single-effect evaporator is selected large enough to produce 5,000 lb. of distilled makeup per hour, when operating under a temperature difference of 66 deg. The next step is to determine whether this evaporator will supply 4,000 lb. of distilled water at half load.

The heat given up in condensing this amount of vapor will be $4{,}000 \times 1{,}000 = 4{,}000{,}000$ B.t.u., which will raise the temperature of the main condensate $4{,}000{,}000 \div 45{,}000 = 89$ deg. (approximately).

With a main-condensate temperature of 85 deg. and 15-deg. terminal temperature difference in the evaporator condenser, the final vapor temperature will be $85 + 89 + 15 = 189$ deg. (11.4 in. vacuum) and the over-all temperature drop available to operate the evaporator will be $221 - 189 = 32$ deg. Since the capacity of an evaporator is practically in proportion to the temperature drop, and the capacity is 5,000 lb. at the full-load drop of 66 deg., the capacity at half load will be about $\frac{32}{66} \times 5{,}000 = 2{,}400$ lb. (approximately). Therefore the single-effect evaporator chosen falls far short

of producing the necessary makeup of 4,000 lb. at half load.

The next step is to try a double-effect evaporator. At full load the total vapor from the two effects must be 5,000 lb., but only that from the last effect, amounting to about 2,500 lb., goes to the evaporator condenser. The temperature rise of the main condensate will then be (2,500 × 1,000) ÷ 90,000 = 28 deg. (approxi-

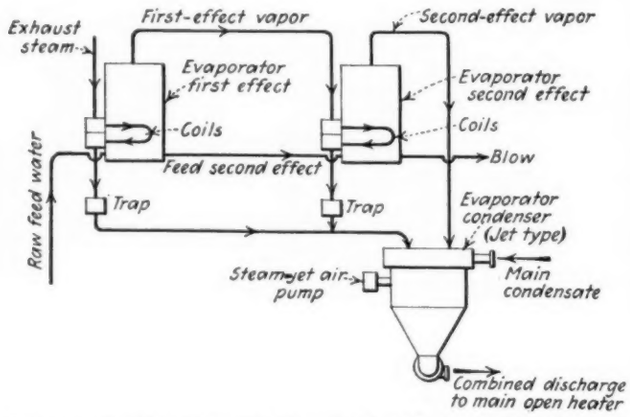


FIG. 10—TYPICAL FLOW DIAGRAM FOR A LOW-PRESSURE INSTALLATION WITH EVAPORATOR CONDENSER OF THE JET TYPE

mately), and the final vapor temperature will be 85 + 28 + 15 = 128 deg. (25.7 in. vacuum). The over-all temperature drop in the evaporator will be 221 — 128 = 93 deg.

At half load the second-effect vapor will amount to about 4,000 × ½ = 2,000 lb. per hour. This gives a temperature rise of (2,000 × 1,000) ÷ 45,000 = 45 deg. (approximately), so the second-effect vapor will be at a temperature of 85 + 45 + 15 = 145 deg. (27.3 in. vacuum), and the over-all temperature drop in the evaporator will be 221 — 145 = 76 deg. Since the evaporator is designed to produce 5,000 lb. of makeup at the full load drop of 93 deg., its capacity at half load will be $\frac{76}{93} \times 5{,}000 = 4{,}100$ lb. (approximately). Therefore a double-effect evaporator large enough for full-load conditions will be ample for half load.

It should be noted that the computations just made are in the nature of rough preliminary calculations. In the actual selection of an evaporator for a given station it is of course necessary to go more into the refinements of calculation. This problem does, however, clearly show that the drop in evaporator capacity from full load to half is greater for a single-effect than for a double-effect evaporator. As the makeup requirements do not drop off in proportion to the load, a double-effect or triple-effect evaporator ordinarily fits in best from the thermal viewpoint. In addition it has the great advantage of giving a reserve in the form of two or three single effects.

In conclusion, attention should be called to the fact that both high- and low-pressure evaporators, when properly fitted into the station heat balance, return to the feed water most of the heat in the steam supplied to them, so that the selection must be made largely on the basis of first cost, reliability and labor required, giving due weight to blowdown and radiation losses.

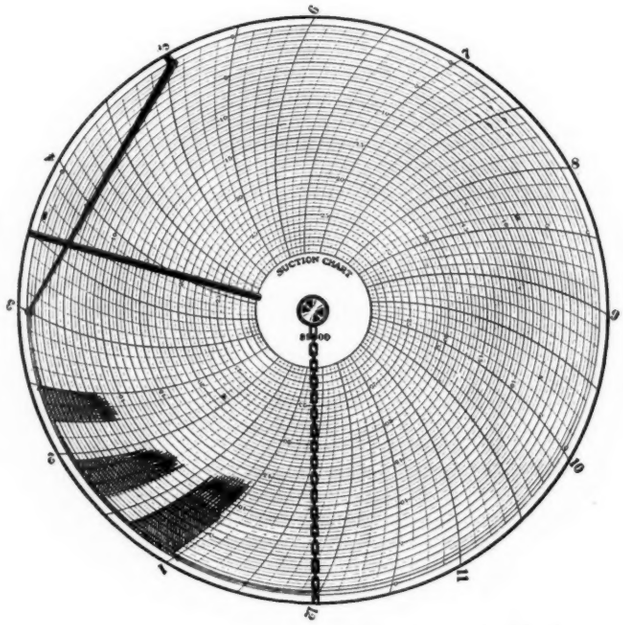
Acknowledgment is hereby made to the Griscom-Russell Co. and to the Wheeler Condenser and Engineering Co. for the use of drawings and photographs.

Remote Control for Steam-Jet Ash Conveyor

To limit steam consumption to the periods when ash is actually being handled in the conveyor pipe line, the Green Engineering Co., East Chicago, Ind., has equipped its steam-jet ash conveyor with a remote-control feature consisting of an electrically operated steam valve, a steam-operated water valve and an air-flow meter with a clock and chart.

When ready to hoe ashes into the intake, the operator puts his foot on a button or board and closes an electric switch. The closing of this switch operates a solenoid which opens the valve controlling the steam supply to the nozzle. Between the steam valve and the steam-jet nozzle a tap from the main steam line leads to a water-spray nozzle. The pressure of the steam in this line opens the water valve, and the water spray in the storage tank functions. As soon as the operator lifts his foot and thus breaks the electric circuit, the solenoid-operated valve is closed by the steam pressure back of it and at the same time the water valve closes owing to the lack of steam pressure.

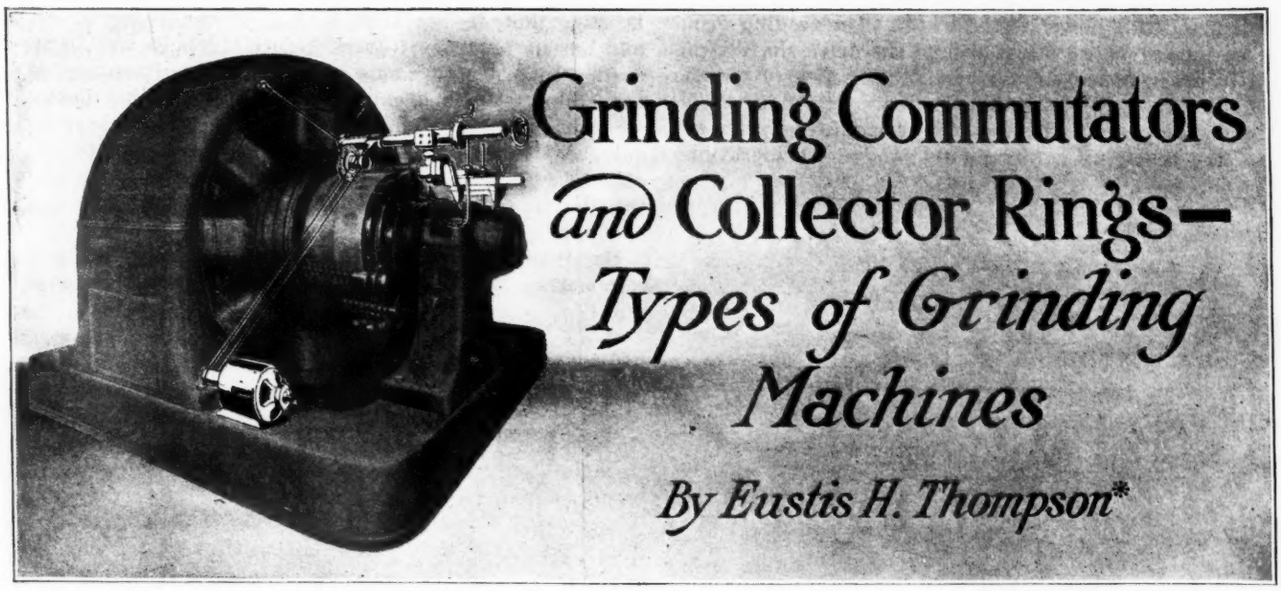
An air-flow meter connected to the conveyor pipe line gives a permanent record of the minute-by-minute suction maintained on the system. It tells the story if the operator lays a brick or a stone on the switch and permits the steam to flow while he is not hoeing ashes into the system. This is shown by the nature of the line drawn on the chart. While the system is in proper



RECORD OF VACUUM IN STEAM-JET CONVEYOR PIPE LINE

operation, the pen will record jagged lines. When no ashes are being moved, the line will be smooth and follow the circles on the chart.

Prior to the introduction of this control, the steam consumption was a variable quantity that often exceeded expectations. From a study of actual operating conditions in numerous plants the company claims that a saving of one-half the present steam consumption is possible, through the use of its new control.



Grinding Commutators and Collector Rings—Types of Grinding Machines

By Eustis H. Thompson*

MANY power-plant operators have developed portable grinding devices for truing commutators or collector rings, with a revolving grinding wheel, for their own needs, and such machines are also manufactured for sale. Various schemes have been used in building these machines, which may be divided into the following classes:

In regard to the guiding member, there are two kinds: (1) One which uses a round shaft or bar for supporting the movable carriage containing the grinding wheel. This type is similar in construction to a boring bar or a cylinder grinder and will be referred to as the "bar type." (2) A device which uses a flat guiding member, such as the guide of a lathe carriage, for supporting the movable carriage containing the

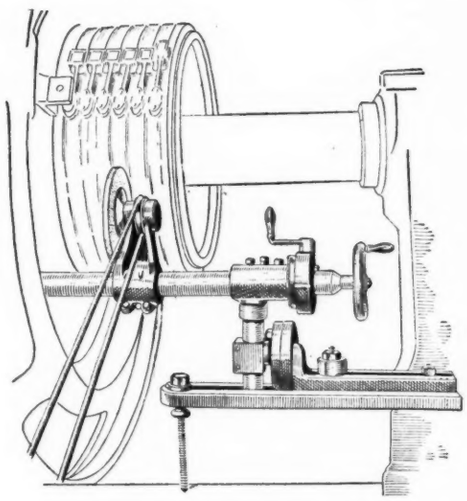


FIG. 1—BAR-TYPE DEVICE, DRIVEN AT WHEEL SHAFT

grinding wheel. This resembles the construction of the original device for turning commutators with a tool and will be referred to as a "plate type."

With regard to driving the wheel itself there are four methods: (A) Belting the motor directly to the shaft on which is mounted the grinding wheel, so that the driving pulley will be moved with the carriage. (B) Belting the motor to a driving shaft that is connected so as to transmit power to the grinding wheel. The driving pulley in this case is practically in a fixed

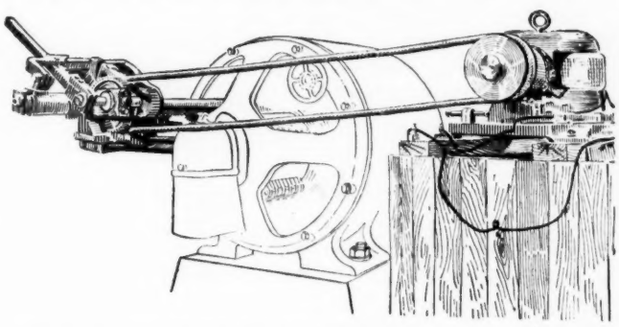


FIG. 2—DRIVING SHAFT GEARED TO GRINDING WHEEL

position. (C) Driving the wheel from the commutator by means of a friction pulley in contact with the commutator. (D) Driving the wheel by means of a motor mounted on the rigging itself.

Fig. 1 shows a Jordan Brothers bar-type machine driving directly at the wheel shaft. This is supported principally at one bearing, on which is mounted the crank for feeding the wheel into the commutator by rotating the bar, and also a handwheel for feeding the carriage along the bar in an axial direction. The mounting mechanism is shown clearly in the sketch, where it is attached to the bottom of a bearing block. It is often necessary to place an auxiliary bearing at the extreme end of the guide shaft and bolt this in some manner to some part of the generator so as to provide a more rigid support.

Fig. 2 shows a bar-type machine that uses a driving shaft for transmitting the power to the grinding wheel.

Fig. 3 shows a Phillips bar-type machine that receives its power from the commutator by means of a friction wheel. This is shown as mounted on the top of a bearing.

*Associate editor *Power*; formerly of Construction Department, General Electric Company.

Fig. 4 is a plate-type machine that uses a drive shaft for transmitting power to the wheel. The feeding member of the carriage swings around the drive shaft as an axis in order to move the wheel into or away from the commutator.

In deciding upon the method of mounting such devices, the following points should receive consideration:

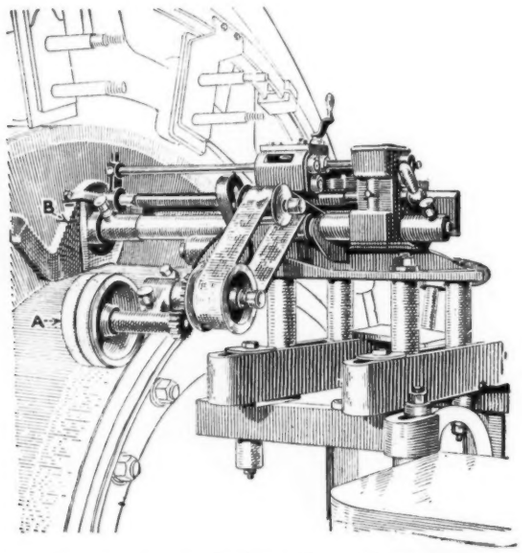


FIG. 3—DRIVEN BY COMMUTATOR THROUGH FRICTION WHEEL *A*; NOTE VACUUM DUST COLLECTION DEVICE *B*

(1) The most convenient supports for the device itself; (2) room required for feeding the wheel and carriage in a radial and an axial direction; (3) interference of the various parts of the machine, and which parts should be removed, etc.; (4) how to secure the necessary rigidity; (5) location of the motor; (6) location of switch and rheostat; (7) location of the devices for feeding the wheel; (8) direction of rotation of machine and wheel, and best position for grinder; (9) method of controlling speed of the machine to be trued.

With regard to the supports for the device to be mounted, a plate-type machine is usually much heavier

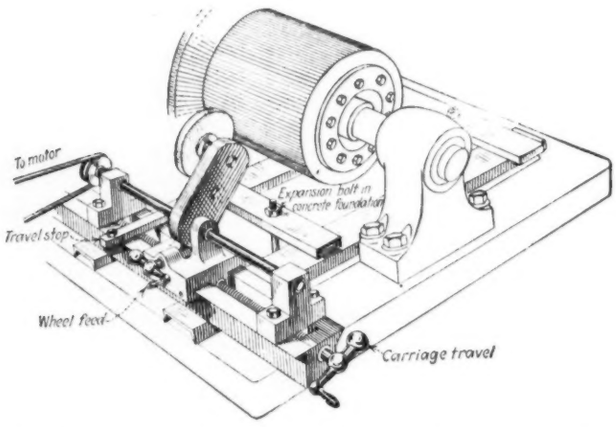


FIG. 4—PLATE-TYPE DEVICE WITH DRIVING SHAFT GEARED TO GRINDING WHEEL

than a bar-type and can be mounted on rails or I-beams as in Fig. 4. The rigging and supports should be clamped down tightly. It is often possible to use the holes for the bolts of the brush rigging, etc., in doing this. Sometimes it is convenient to drill the concrete floor and locate expansion bolts for this purpose. It is important to see that such a device bears evenly and has no tendency to rock before the bolts are tightened. In order to compensate for the unevenness of the supports, shims can be placed under this device so as to prevent rocking and to provide a good bearing surface. In some generators it is convenient to lift off half of the field frame and brush yoke so as to rest the device on the joints of the lower half of each member.

Bar-type grinding devices are comparatively light and can usually be mounted without requiring the removal

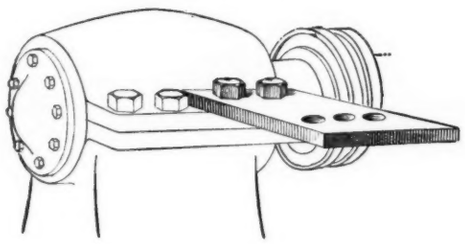


FIG. 5—LARGE BEARING BOLTS CLAMP PLATE SECURELY

of as much brush rigging as in other types. In large generators with heavy substantial brush studs, the device may sometimes be mounted directly on the stud itself, together with an extra support bearing at the end of the bar fastened to some part of the machine. In medium or smaller machines the device can be best mounted on a beating pedestal. Manufacturers provide special devices for the pillow block, illustrated in the headpiece.

When grinding devices are mounted on a pillow block, it is often most convenient to use a steel plate varying from one-half to one inch in thickness, drilled to fit the pillow-block bolts, and also for the bearing supports of

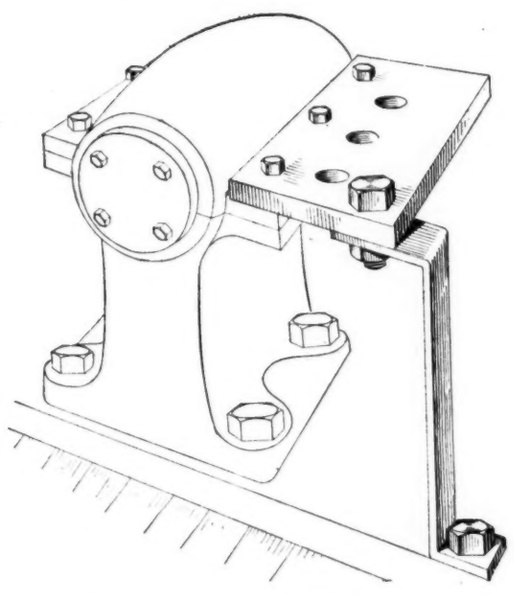


FIG. 6—SMALLER BOLTS MAKE REINFORCEMENT NECESSARY

the grinding device. On large pillow blocks such a support may be mounted from the bearing bolts as shown in Fig. 5. In smaller machines, where bearing bolts are smaller, they cannot be used alone, and it may be necessary to brace such a plate from the foundation, as

shown in Fig. 6. In small machines there are sometimes no bearing bolts available, and it may be necessary to secure a support from the foundation and the top of the pillow block, as shown in Fig. 7. One plate can often be drilled to fit a number of bearings to accommodate several different positions of the grinding device so that it can be used on a number of jobs. The type of generator shown in Fig. 8 contains neither bedplate nor bearing bolt large enough for mounting purposes. The grip clamp can be utilized in such a case to advantage, as illustrated in the figure. Sometimes it is more convenient to omit the generator or motor altogether for supporting the grinder and build a blocking on the floor entirely independent for mounting the grinder.

Room must be allowed for feeding the wheel into the commutator as well as for moving the carriage in an axial direction. The wheel will necessarily be close up against the end conductors or necks at one end of the commutator and will be close to the outer edge of the other end. The carriage in the last instance may extend close to the supporting brackets. Care should be taken to see that the guide will give the right carriage travel for each extreme position so that the entire grinding can be done with one setting of the device.

It will be a great convenience in handling grinding devices if travel stops are provided on the guide member, so that the carriage will be stopped when the wheel is as close to the necks as it can go without touching. This will save the operator a good deal of trouble, as it is hard to judge this distance when the machine is at speed. Clamp rings can be used on bar-type guide machines or clamp straps on plate-type, Fig. 4.

Interference from the various parts of the generator or motor should be carefully studied when deciding on

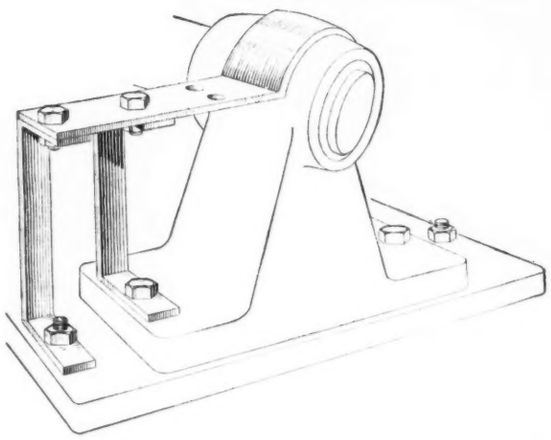


FIG. 7—MOUNTING DEVISED WHERE NO BEARING BOLTS ARE PROVIDED

the position for mounting. It is desirable to place the grinder so there will be as little disassembling as possible. On very large machines it is sometimes possible to do without any dismantling and often a few brush-holders or one brush stud is all that is necessary to be removed.

While the grinding device with a rotary wheel does not require the rigidity of the turning device suitable to withstand a heavy cut or gouging and while the grinder can be worked to best advantage while cutting freely, it is, nevertheless, desirable to have reasonable rigidity, as otherwise there will be chattering and difficulty in grinding high spots. After the machine is mounted, the carriage or wheel shaft should be pulled by hand to see how much deflection is produced by such a strain on the wheel. The grinding wheel should be carried in a positive manner so that it can be fed without appreciable deflection of its supporting members. It is often necessary to support the bearing at the end of the guide by fastening it to some part of

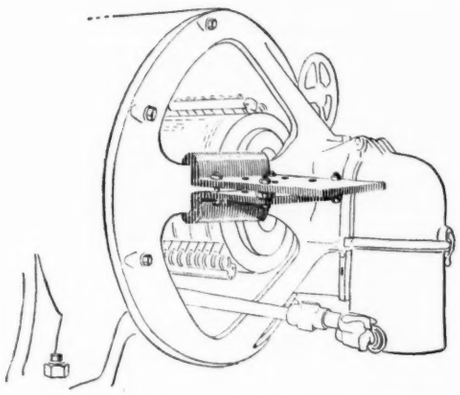


FIG. 8—GRIP CLAMP APPLIED FOR A MOUNTING. NOTE MACHINE IN FIG. 2

the machine in addition to the other bearing in order to provide strength. Vibration should be avoided by sufficiently solid mounting. The pull of the belt also tends to place a strain cn the device. If a grinding wheel can withstand a 100-lb. pull with only a slight deflection of about $\frac{1}{64}$-in., it should be O.K. Give it a good pull in each of several directions and find out.

Ten feet between pulley centers should be satisfactory for a round belt. It is difficult to get a good joint in such belts, as ordinary lacings will usually give trouble. One of the best schemes is simply to use a steel hook of drill or wire stock of about $\frac{1}{16}$- to $\frac{1}{32}$-in. diameter. A large hole should be punched in each end of the belt so that the hook will have flexibility in going over the pulley. The round belt should not usually be tight. The belt can pull either on top or bottom.

Capacity of Driving Motor

The actual power for ordinary grinding devices is about one horsepower. It is desirable, however, to use a motor of from three to five horsepower so that in case of an extra-heavy pull there will be no drop in speed. It is important to have the pulleys arranged to give overspeed rather than underspeed, as there is no particular harm in running overspeed, while the wheel will wear out rapidly without cutting if the speed is too low. With a direct-current motor it is usually convenient to have a rheostat in the field for varying the speed. In case the speed of actual grinding is too high, it is not advisable to use resistance in the armature circuit for slowing down, as this makes such a large variation of speed in the cutting wheel.

The switch and starting rheostat for the grinding motor should be placed within easy reach of the operator so that the motor can be started easily and in case of trouble a quick stop can be made. It is sometimes most convenient to fasten a string to the line switch, one end of which is tied near the operator so that he can open the switch instantaneously and thus stop the motor.

The grinding device should be located so that the

operator can reach the levers for feeding the wheel conveniently. Where a large machine is being ground, a good seat for the use of the operator is often much appreciated.

The grinding device can be placed at the top or side or in any other desired position near the commutator. The principal point that governs the position of the grinding device is the direction of rotation of the commutator or collector rings to be ground. The grinding wheel ordinarily runs in the opposite direction to this and is usually most satisfactory when the cuttings from the commutator are thrown *downward* instead of upward. In the latter case the dirt can be collected and prevented from reaching other machines more easily.

The question of controlling the speed of the machine to be ground must be considered. It is preferable to grind at normal speed of generator or motor, so that the commutator will run true when the machine is under load. If the commutator should be ground at low speed, the centrifugal strains often make it run slightly out of true in normal operation. When a prime mover is connected to the generator, the question of speed takes care of itself. In the case of a rotary converter or large motor it is necessary to do the grinding while under voltage or else use a special motor for driving the machine to be ground. Most grinding wheels are sufficiently insulated for 1,000 volts so that no other insulation is necessary.

Testing Steam-Cylinder Oils

By W. F. OSBORNE

Supervisor Manufacturers' Service, Texas Company

ONE of the most difficult tests the engineer is called upon to make, is a comparative test of two cylinder oils, with the view of determining which is the more suitable for his local conditions. Such tests are hard to make because of the many factors that influence lubrication and the difficulty of controlling these factors within close enough limits throughout the entire test.

In order to eliminate the variables of cylinder metal, surface condition, piston and ring conditions and engine design, all comparative tests should be made on the same engine. If two engines are used, both oils should be tried out on each engine, and the average of the two results taken.

Other variables that should be controlled if results of any value are to be secured, are steam pressure, exhaust pressure, per cent of moisture, engine speed and load. If these factors are maintained constant, in so far as is practical, the only other variables to be considered in a single engine are the oil feed and the suitability of the oil, the former varying with the latter. This brings us down to the question of regulating the amount of oil supplied to the cylinder and measuring the results.

A cylinder-oil test should include the measurement of cylinder and piston wear, frictional losses and oil consumption. The first item, cylinder wear, is very difficult to measure when the cylinder is lubricated anywhere near efficiently, because the rate of wear will be so small that many months will elapse before it can be judged with any degreee of accuracy. Obviously, during such a period the operating factors would vary so much that no comparative figures could be secured. We must depend, then, upon the measurement of the frictional losses and the oil consumption, together with a careful examination of the surface of the cylinder at frequent intervals to determine its condition.

Frictional losses are sometimes measured by means of indicator diagrams and brake-horsepower tests, either with a Prony brake or by measuring the output of an electric generator. In either case all conditions should be maintained constant throughout each test, as previously suggested, with the exception of the quantity of oil fed. If the action of the oils under various conditions is to be examined, each changed condition should be considered as an entirely different proposition and a complete test made along the lines to be outlined later. For instance, if the engine operates under variable load, a complete test should be made with the generator delivering full load. Then another test should be made at half load and another at quarter load.

When the brake-horsepower is maintained constant, it is possible to determine the conditions of maximum lubrication by measuring the difference in the indicated horsepower as shown by the indicator diagrams. The best way to make such a test is to reduce the oil feed at regular intervals, taking indicator diagrams every fifteen minutes until the indicated horsepower becomes constant for each rate of feed. The principal difficulty in making a test of this character is the time required for each change of oil feed to become effective.

The reduction of the oil feed is continued at regular intervals, until the indicator diagrams show that the indicated horsepower is beginning to increase. The lowest quantity of each oil that will give minimum friction losses, can be used as a comparative value of the oil from an economical viewpoint. The oil that gives the lowest frictional losses, regardless of quantity used, would be considered as the most efficient from a lubricating point of view. The relative costs of the oil and of the horsepower lost would determine the relative suitability of the oil for that particular engine.

The greatest of care must be exercised in securing the indicator diagrams and measuring the output of the generator or the load on the Prony brake, as the difference in the friction developed by the use of any one oil will vary only slightly over a considerable range of oil feed.

Such a test will indicate the relative value of the two oils over a short period only. Some account must be taken of the ability of the oil to continue to give as good service throughout an extended period. The best way to get an idea of the suitability of the oil in this respect is to examine the condition of the cylinder wall and the oil film upon it after the expiration of a week's run, and possibly again after two weeks' run.

To do this, the cylinder wall should be examined carefully before starting the test and its condition noted with respect to rust, polish, color, porous or rough spots, score marks, bright streaks due to wear, and the condition of the piston and rings with respect to sharp edges, and wear marks.

Having established the condition of the cylinder, the lubricator should be cleaned out, and if there is any

possibility of the oil lines being plugged up, they too should be cleaned out, by blowing them out with steam. If one of the oils to be tested is the oil previously used on the engine, it can be tested first, in order to save time, for reasons that will be brought out later.

The rate of feed from the lubricator is brought down to the lowest point at which good lubrication can be secured, as indicated by the action of the engine, cylinder sounds, valve-rod vibration or, when indicator diagrams are taken, by the point of least friction. If the engine runs only a part of each twenty-four hours, the cylinder may be examined at the end of each day if desired; otherwise an examination can be made as often as permitted by the operating hours of the engine.

When indicator diagrams are not being taken, and the amount of oil feed is determined solely by the operation of the engine and the condition of the cylinder on examination, such inspections should be made as frequently as convenient. If, on inspection, the cylinder shows the presence of too much oil, the feed can be reduced and another run made. When too little lubrication is indicated, the feed should be increased and the run repeated. As soon as the proper feed has been determined, a test of at least one week should be made at that rate of feed, and the condition of the cylinder, at the end of that time, carefully compared with its condition at the beginning of the week.

Changing to Another Oil

When the change is made to the next oil, after cleaning the lubricators and filling them with fresh oil, the oil should be fed at a high rate for several days in order to saturate the cylinder wall thoroughly with the new oil and to entirely remove the old from the metal. Otherwise the true value of the second oil cannot be determined on account of the influence of the cylinder polish developed with the first oil. This is why it was suggested that the oil in use on the engine be tested first in order to save time required for building up a new film each time. The oil can then be reduced and a test made as outlined before.

At the end of each test the cylinder should be opened as quickly as possible after the engine has been shut down in order to get an idea of the condition of the cylinder before the oil has had an opportunity to evaporate or become destroyed by condensing vapor. A good way to compare the relative amount of oil on the cylinder wall is to take saturation impressions on thin paper. The paper should be the same in each case, as the various grades of paper have different thicknesses and rates of oil absorption. Riz la Croix cigarette paper is quite uniform in quality and thickness and is very good for this purpose.

To make the saturation test, four or five thicknesses of the paper are taken in the hand and pressed against the cylinder wall for about five seconds, care being exercised to have the pressure as uniform as possible. Saturation tests are made at four points—top, bottom and each side of the cylinder, at the center of the stroke. If the oil penetrates one thickness of paper and stains the second sheet slightly, we can consider that there is a proper amount on the cylinder wall for lubrication.

Of course such a test is comparative only and, being subject to many variables, some experience is required in order to secure results of any value. For instance, the temperature of the cylinder wall and the oil film should be the same on each test in order that the relative fluidity of the oils will be in accordance with their viscosities at the operating temperatures.

The oil stain will be light brown in color and perfectly clean, free from dark specks or streaks. Should it be dark or streaked, it is evidence of decomposition, due possibly to an excessive oil feed. Dark specks in a clear stain indicate metallic wear of cylinder or piston, or they may possibly come from boiler compound carried over with the steam.

The cylinder wall is then carefully examined and its condition compared with that noted on the first examination. If there are any new bright streaks, the piston and rings should be given close attention to see if they are also worn. Bright streaks sometimes come from foreign substances getting into the cylinder and in such cases are in no way attributable to lack of proper lubrication. They usually come from improper oil and insufficient oil, and their cause should be determined and removed.

Porcus spots and dry spots, if new, may be due to the oil having been scoured off the cylinder wall by the steam. They can be eliminated by using more oil, and the oil that will prevent their appearance with the least amount of consumption would be considered the most suitable.

Low-Pressure Economizer with a High-Pressure Boiler

Theoretically, the pressure maintained on an economizer need be only a little higher than that corresponding to the temperature to which it can raise the feed water. This pressure is usually well below that in the boiler. It would seem that if economizers could be operated in this manner, there would be a saving in first cost due to the reduced pressure, and also a saving in maintenance.

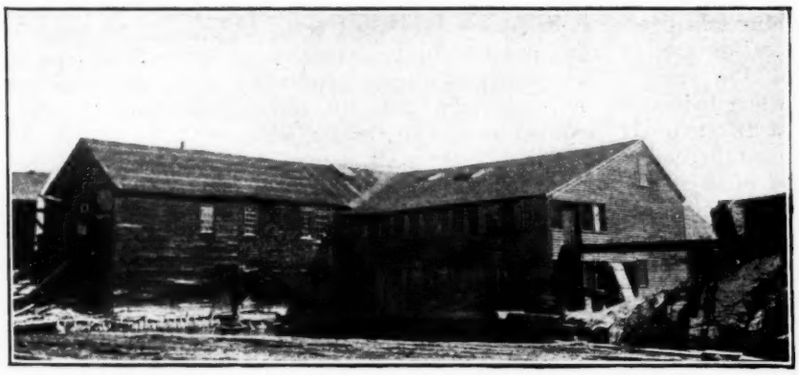
The general application of this idea has been delayed by the feeling that the accurate regulation of pressures, under conditions of variable load, was a difficult problem.

This difficulty seems to have been solved in the L-Street Station of the Boston Edison Company. In that plant a Sturtevant economizer is operated at 160 lb. gage pressure, whereas the boiler pressure is 300 lb., the boiler feed pump operating at 350 lb. gage. Under full-load conditions the water enters the economizer at 140 deg. and leaves at 240 deg.

This arrangement is made possible by the system for the control of flow and pressure. The boilers are equipped with automatic feed-water regulators designed to maintain a constant water level. The economizer feed pump and the boiler feed pump have individual controls whereby the supply of steam to the turbines driving the pumps is controlled by the water pressure at the pump discharge. It is said that the system operates without surging, hunting or other irregularities.

On account of lack of experience with installations of this type an economizer designed for high-pressure operation was used in this case, but it is believed that low-pressure economizers could be successfully used with a large saving in initial cost. Another application would be in the case of stations already equipped with economizers and medium-pressure boilers, where it is desired to increase the boiler pressure without replacing the economizers. This could be done by operating the economizers at a lower pressure.

A Century-Old Tide Mill



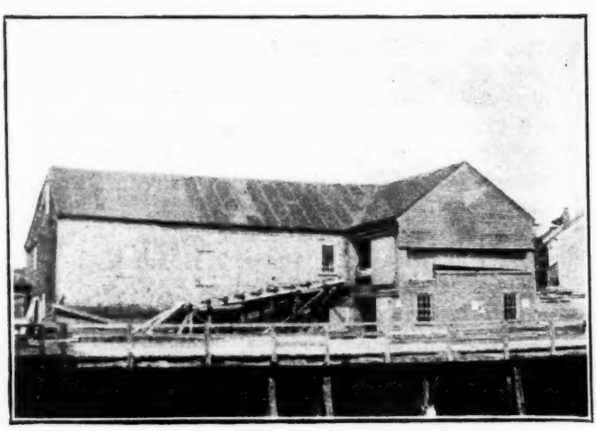
IT SHOULD be a matter of no small interest to American engineers that the moon, through the tides which it causes, has been sawing lumber for ninety-six years in a small shipbuilding town on the Maine Coast. In 1826 Caleb Hodgdon, of Westport, Me., started down the coast in a "pinkie" and eventually sailed into his future mill pond, a land-locked tidal basin in East Boothbay at the mouth of the Damariscotta River, which lies about fifty miles east of Portland. The pond covered about forty acres, yet its connection with the harbor was narrow, and could be closed by an inexpensive dam. So Caleb built a mill with an undershot wheel. By means of a crank this drove a vertical reciprocating saw which cut lumber for local shipbuilding.

About 1870 this pioneer turned the mill over to his sons, who rebuilt it in part, replacing the undershot wheel with a turbine and adding a planer to the equipment. In 1895, after the death of one of the sons, the mill became the property of its founder's grandson, C. Tyler Hodgdon, who soon made extensive changes including the installation of two new turbine wheels.

At the top of this page is a recent photograph of the tide mill showing some logs floating in the mill pond. Directly below it is a view of the forty-acre mill pond, with the position of the mill indicated by the arrow. On the upper right C. Tyler Hodgdon is seen standing in front of the mill, which he owns and operates. The two pictures at the bottom of the page show the mill viewed from the harbor and the mill pond as seen by one looking west from the mill.

Whenever the water level in the harbor is higher than that in the mill pond, water flows freely to the pond through channels passing under the mill. When the outside level falls, automatic gates close these channels and thus prevent the water from flowing out of the pond except through the turbines. After the tide has fallen about three feet below the pond level, the mill can start with about twenty-five horsepower. It can then continue to run through the remainder of the outgoing tide and over part of the incoming tide. By running one shift on each ebb tide, the mill is operated for eight hours each day. In this district the total rise and fall of the tide ranges from nine to eleven feet, giving a maximum available head on the turbines of about nine feet, and a maximum output of about one hundred and thirty horsepower.

The present machinery includes one fifty-eight-inch rotary saw, one gang edger, one clapboard saw, one clapboard planer; one planer and matcher for large lumber, one four-sided planer and a number of smaller machines. This mill, which produces about 700,000 ft. of lumber each year, sawed the oak for the "Bowdoin," the ship which MacMillan used for his recent Arctic explorations.



EDITORIALS

What Should the Draft Be?

THAT "there is more than one way to kill a cat" has been shown time and again. In this case the "cat" is air leakage. We know that low CO_2 is due largely to the air that comes in through the cracks and pores of boiler settings. The obvious way to prevent this leakage of air is to seal the cracks and pores.

At first sight this might seem to be the only way to do it. Yet leakage depends on two factors, of which the "leakiness" of the setting is but one. The other, equally important, is the pressure difference between the inner and the outer surfaces of the setting. The elimination of this pressure drop would stop leakage as completely as if the actual openings were sealed, but this would require that the draft at all points from the top of the fuel bed to the end of the last pass be zero. This is manifestly impossible on account of the necessary drop through the tubes. Without forced draft it cannot even be approximated.

With forced draft it is possible to maintain the draft just over the fire a little above or below zero as desired. In either case the average draft for all points beyond the top of the fire would be relatively small, with the result that the air leakage would be only a fraction of that existing when the draft over the fire is high. As far as boiler efficiency is concerned, this is the main point brought out by E. M. Eliot, in his article, "The Draft over the Fire," in this issue.

But there are other considerations besides efficiency. The maintenance of the settings must be considered. Granting that the draft over the fire should be close to zero, it makes a lot of difference whether it is a slight positive pressure, exactly zero, or a slight draft. Mr. Eliot argues convincingly that operation with a slight positive pressure over the fire causes inconvenience to the firemen and reduces the life of brickwork and instrument taps. An exact zero of draft is practically impossible. This leaves the slight draft, which protects the brickwork without causing excessive air leakage. The subject is worth the careful consideration of every engineer who operates a boiler plant.

Feed-Water Treatment a Big Problem

MUCH has been written on the various phases of feed-water treatment, but the subject is still imperfectly understood by most engineers. This is not surprising inasmuch as the art is full of complexities and is in a state of rapid development. Yet the operating engineer cannot, like the scholar, choose his own problems; he must take the ones that are thrust upon him by nature and his job.

Feed-water problems are among the most insistent. Scale deposits reduce efficiency, cause the loss of tubes, throw boilers out of service and require much labor for removal. Large amounts of dissolved solids cause priming or lead to an excessive blow-down loss. Dissolved oxygen eats away costly metal. These conditions are aggravated under the operating conditions found in many of the modern plants. As a result of all this, many old ideas and some new ones are being applied to the feed-water problems of the modern plant.

To cover the subject broadly and, in particular, to give careful consideration to the more recent developments which are less familiar to the average engineer, *Power* is running a number of articles on the treatment of feed water. Each is written to be understood by itself without reference to others in the series.

The first article, in the September 12 issue, showed how the zeolites are used to soften water. The present issue contains much information on the application of evaporators in stationary power plants. Marine engineers have used the evaporator for many years in the distillation of sea water. It has also been widely used in the evaporative processes found in the chemical industries, but it is, comparatively speaking, a new comer in the stationary power plant, although a large number of installations have been made in the last few years.

Early issues will contain articles on the lime-and-soda process and the removal of corrosive gases. The whole series is designed to be directly helpful to the reader who now has feed-water problems or may have them in the future.

Accident Prevention by Higher Executives

ACCIDENTS constitute a great source of waste and often receive less attention than economy of material or labor. The latter registers directly on the expense account and frequently compels greater initial consideration than loss of life or limb, which can only be surmised and which requires special study and experience in order to be understood.

J. H. Eustace, chief operating engineer of the Peoples Gas Light and Coke Company of Chicago, in his address before the National Safety Council, points out that this condition is not generally appreciated. Accidents in Ohio cost eighty million dollars from 1912 to 1920 and resulted in additional loss due to greater labor turnover and its effect on production. Statistics indicate that seventy-five per cent of the accidental deaths in this country are preventable, and indicate an almost criminal unconcern of the value of human life.

Educational and safety propaganda are necessary and useful, but will not always accomplish results alone. The man in charge of the job is often the real though unrecognized cause of accidents.

An experienced man undertook to clean foreign material from a sixty-thousand-volt disconnecting switch with the power on, which was against strict regulations. His life was lost, and in fairness it cannot be said that any great amount of blame could be attached to those in charge. A prime mover in an inclosed space ran away and exploded. Men working near it were killed by steam while trying to escape. The hand throttle valve was not accessible, as otherwise, the steam could

have been shut off in time; the designing engineer did not figure on an accident. Men have been sent to turn steam into headers on many occasions where water was encountered and an explosion produced. The chief engineer did not take the proper precautions in supervising the work. It would not have occurred if he had taken the chance himself, with proper precaution in the beginning.

How many times in the drafting room is the price of a valve, pipe connection or disconnecting switch saved at the cost or risk of an accident? Ignorance of the danger involved or unwillingness to incur expense is often commented on by the practical men who operate such devices. An instance could be mentioned in which the dangerous condition of a badly aligned machine was pointed out, but the judgment of the operator was discounted. An explosion occurred as predicted, though fortunately without injury to human beings.

Safety precautions often involve an engineering knowledge and practical skill that cannot be learned from books or statistics. It is not the desire to avoid expense so much as the lack of true appreciation of the risks involved that frequently leads to disastrous mistakes.

Mr. Eustace suggests "the man on the job is, after all, in the best position to judge unsafe conditions and practices, and if he is taught to think safety and encouraged to make suggestions for accident prevention, he not only becomes a booster for safety, but feels that he is something more than a cog in the machinery and becomes a more efficient workman."

"Such training, however, cannot be imparted without being supported, not only in theory but in fact, by the executives of the company; with the personal interest of such supervisors and the chief engineers and the knowledge throughout the organization that this support and interest is really accorded. To satisfy the men that the company is in earnest, all suggestions as to safety received from an employee, whether good or bad, should be acknowledged, so that the man may feel that his efforts toward safety are appreciated."

Muscle Shoals Again

ANNOUNCEMENT has been made that the Federated American Engineering Societies will appoint a committee to study and report on Muscle Shoals.

Since Mr. Ford submitted his proposal over a year ago, the proposition has been a subject of bitter controversy in Congress, involving extensive propaganda by the fertilizer and allied industries and the local power company on one side and the agricultural interests on the other. Although the offer seems to have been sidetracked temporarily, the problem of what to do with Muscle Shoals is yet to be settled.

An impartial investigation by the Federated American Engineering Society would do much to settle the controversy, besides adding to the prestige of that body. But it is not enough that the investigation be impartial, the personnel of the committee selected must be such as to preclude any suspicion of bias. At the very start the Federation is handicapped by the fact that the gentleman at whose instance the motion was made prefaced the resolution by a speech in which he vigorously denounced the Ford offer.

The committee will be in fact a jury of engineers responsible to the sixty thousand engineers it represents and having a duty to the country as a whole. Its selection should be governed by qualifications such as apply to juries at court. It would be a grave mistake to select anyone who has expressed or is known to have fixed sentiments on any of the propositions thus far made, and no one ought be considered whose business affiliations either directly or indirectly would have any influence on his decision, for there are many whose personal integrity is aboveboard, but whose long training and business connections have made it difficult to view both sides of a proposal. Moreover, any personal opinions concerning Mr. Ford should hold no weight.

Ostensibly, the Federated American Engineering Societies represent, the best engineering thought in the country, but it is still young and its activities thus far can hardly be said to have given it the prestige desired. A misstep at this stage of its career would be disastrous, hence its consideration of a national problem such as Muscle Shoals must be surrounded with every safeguard.

The Useful Art of Estimating

TO THE average observer there is something almost uncanny about the ability of certain engineers to make rapid mental computations. In a minute or two they obtain a close approximation to the answer which others produce only after long labor with a pencil. The more gifted of such men undoubtedly have a highly developed mathematical sense. On the other hand, almost any intelligent engineer can acquire much of this skill.

The basic necessities are: (1) Clear mental pictures of the fundamental principles of engineering; (2) keen judgment to distinguish between the essentials and nonessentials of any problem, so that all of the latter can be eliminated; (3) a memory stored with a few dozen of the more important engineering constants; (4) a knowledge of approximate mental arithmetic; and (5) constant practice.

Under item 4 comes discrimination in choosing round numbers, some a little high and some a little low, which simplify the work without introducing too great an error. In the same connection there are many well-known short cuts—such as dividing by 0.2 instead of multiplying by 5—that, taken all together, save a lot of time.

In rapid-fire work of this sort, while making what seem to be crude approximations at every step, it is easy to keep the final result within ten per cent of the correct answer. Then it can be seen whether the problem is worth more careful consideration. If not, much time has been saved. If, on the other hand, it appears that a careful recomputation is desirable, the original mental solution has some value as a rough check on the final result.

"Among many Senators there is doubt of the legality of either of the (coal price fixing) bills."—*Coal Review.*

There is no doubt in the public mind of their necessity; and a growing determination on the part of the people no longer to submit to legalized robbery is likely to be more potent than the legal scruples of a few Senators from the coal districts.

Well anyway! We wanted to continue the United States Fuel Administration.

Is the coal business "charged with public interest" these days?

PRACTICAL IDEAS from PRACTICAL MEN

The Flywheel Question

Some engineers think they save a few hard-earned dollars on the purchase of a new engine by ordering a lighter flywheel than the builders specified and recommended.

The result of this so-called economy is that every time that a number of mills get thrown on at once, you are slowed up, and if they happen to be thrown off at the same time—which occurs oftener than one would at first think—the engine has to be throttled down until she catches her breath right. Cast-iron is cheap, but experience may be expensive; and you always have to buy it just when you can least afford it.

Let's do some figuring. But we will first think a moment. "For what purpose is a flywheel?" To store up unnecessary power temporarily or, rather, superfluous power, and give it out in a shortage. The heavier it is the more superfluous power it will store up. There should be enough weight to store up all the energy that the engine will develop in from six to twelve strokes. The only loss of power by having an extra-heavy wheel is in the comparatively slight increase in friction of the main bearings; this of course should be provided for by a stouter shaft and extra-long bearings and journals. And that loss is always less when the wheel is at the end of the shaft next the crankpin.

Take, for instance, an engine of 250-hp. The wheel is 13 ft. in diameter and the speed 100 r.p.m. Being a throttling engine, it needs more wheel weight than if it were an automatic cutoff—say 40 lb. per horsepower, or in all 40 times 250 equals 10,000 lb. You have only about 7,500. If it had been an automatic, you would have needed 30 per cent more. As the shaft and bearings are heavy and long enough, respectively, for a heavier wheel, it would be well to order one of at least 12,000 lb., on account of the fluctuating nature of the load.

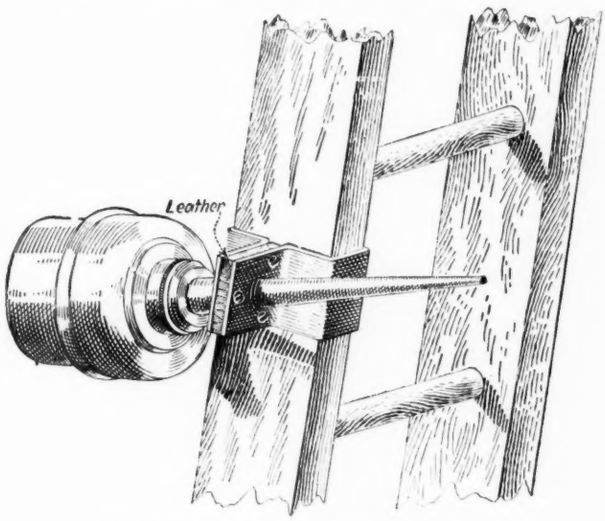
ROBERT GRIMSHAW.

New York City.

Ladder Attachment for Holding an Oil Can

The illustration shows a ladder attachment for holding an oil can in a convenient manner while the operator is engaged in screwing off the caps or cleaning out holes preparatory to lubricating bearings. Generally, if a beam is handy above the shaft it is used for this purpose, but this is dangerous in many instances because it compels the operator to climb the ladder a few more steps and thus bring his clothes into close proximity with the revolving pulleys.

To make this attachment, a strip of sheet metal about two inches wide is bent to fit the side of the ladder as shown, and in the center of the projecting ends a hole is drilled large enough to admit the oil-can spout, and smaller holes are drilled for clamping screws. Before final clamping, however, a piece of leather with a hole in the center slightly smaller than the hole in the metal is inserted between the two ends. This holds a large oil can very handily, the leather gripping securely enough to prevent it falling out under vibration.



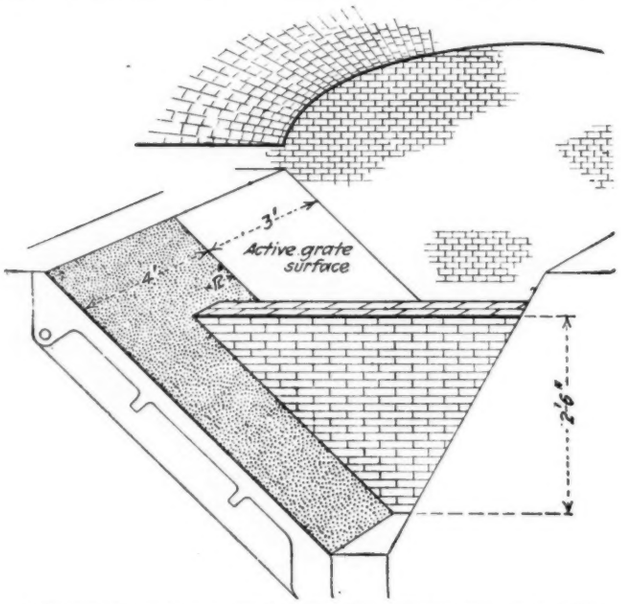
OIL CAN IS HELD IN HANDY POSITION

Montreal, Canada. HARRY MOORE.

Ignition Wall in Furnace Increases Efficiency

Our boiler plant consists of two water-tube boilers with 3,140 sq.ft. of heating surface, and equipped with 7x7-ft. automatic furnaces with sprung arches. During the winter season the load varies from normal rating up to 167 per cent of rating and the boilers are operated efficiently. During the summer period the load drops

to about 45 per cent of rating and the efficiency falls down. It has been the practice every spring to shorten the grates four feet. This gives about the right grate area for the load, but with the large combustion space it was found difficult to maintain the required furnace temperature and the gases did not mix properly, the result being incomplete combustion. It was never pos-



IGNITION WALL INSTALLED IN FURNACE FOR LOW RATING OPERATION

sible to get more than 5.5 per cent CO_2 for an average of twenty-four hours or an evaporation of more than 6 lb. of water per pound of coal, the fuel used having a heat value of 13,500 B.t.u. Oil burning was considered, as it was thought that the air for combustion could be better controlled, which would help to overcome a certain amount of this loss. This, however, would still leave the same combustion area to contend with.

Before putting the boiler into service this spring, we installed an ignition wall, as shown in the illustration, on top of the portion of the grates that was blocked off. This wall was placed one foot beyond the effective grate area to allow space for any clinker formation so that it would not interfere with the operation of the grates. The distance from the crusher bar plate to the top of the wall was 2 ft. 6 in. The results obtained have been quite satisfactory, and it is now possible to maintain a temperature in the furnace almost equal to the winter conditions. The average CO_2 has increased to about 7.75 per cent with a corresponding increase in evaporation to 7.50 and 7.85 lb. of water per pound of coal. The saving in fuel for the three months ended July 31, 1922, was 91 tons. This is a saving well worth while.

Montreal, Quebec, Canada F. ATKINSON.

An Economical Steam Plant

It is unfair to claim that steam power is more expensive than other kinds, when modern practice and up-to-date methods in designing and operating are ignored in favor of low first cost and inexpensive management in practice. Owners of small plants seem to think that while it pays to install modern devices in large plants, it is a waste of money to put in anything but the most crude appliances in small plants. While the total that can be saved in the latter is much less than in the former, the total first cost is less accordingly, hence the percentage of saving may be nearly as large.

The following description of a plant to develop 60 hp. and to supply steam for heating and drying will show what is desirable and economical along this line. It is assumed that only exhaust steam is required for heating (or perhaps a small quantity of live steam) while the engine is in operation. When it is shut down, the whole power of the boiler is available to supply live steam.

For this purpose a return-tubular boiler will be satisfactory. The approximate size would be 60 in. in diameter and 14 ft. long. The heads may be fitted with 60 tubes 3 in. in diameter. The boiler should be suspended independent of the brick setting, as illustrated in Fig. 1. I-beams rest on substantial brick piers and carry the weight of the boiler. The grate is 5x5 ft., dumping in two sections, in order that the fire may be quickly and thoroughly cleaned. The shell ought to be 36 in. above the grate, with a flat top bridge wall 18 in. high. The space beyond this wall is not to be filled in with earth, but made as deep as practicable, in order that it may not require frequent cleaning. The distance from the rear head to the brick wall may be about equal to the diameter of the shell.

Forced draft should be produced by a steam jet blower. This is recommended because a small quantity of steam delivered with the air under the grate assists combustion and practically prevents the formation of clinkers on the sides of the furnace. Any desired draft can be obtained and it is then possible to burn the finer sizes

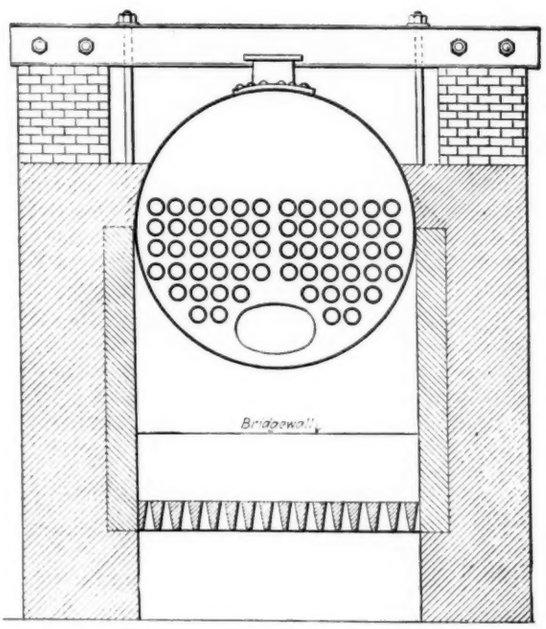


FIG. 1—SECTION OF SETTING FOR SMALL BOILER

of coal, thus using what in many plants is a byproduct that can be bought at a low price. For illustration, if soft coal is $8 and anthracite dust is $2 per ton, a mixture of one part of the former to three parts of the latter makes the coal cost $3.50 per ton, and good results can be obtained with it. Modern blowers can be operated with about 3 per cent of the power generated in the boiler.

Fig. 2 shows the simplicity of the apparatus. An ordinary damper regulator operates the damper and

controls the steam to the blower. There is also a draft gage to indicate the draft secured at all times. The top of the boiler should be covered as well as all pipes that convey steam or hot water.

The boiler might also be equipped with a water column fitted with a high- and low-water alarm. Where this is considered an essential feature of the equipment, and is kept in working order, in service the boiler will

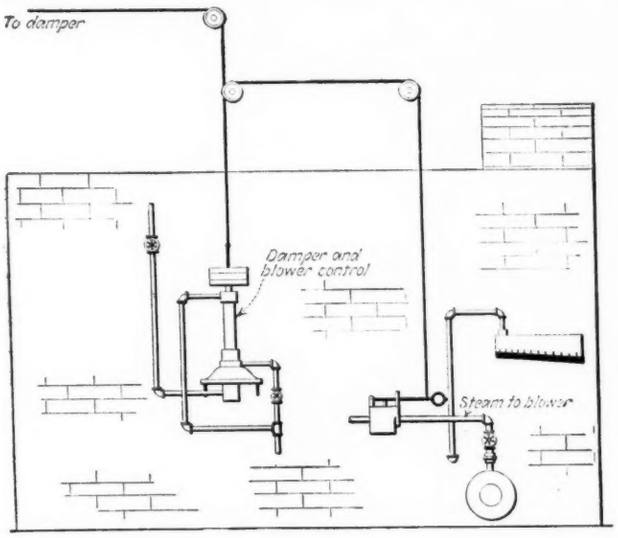


FIG. 2—REGULATOR CONTROLS REAR DAMPER AND STEAM TO BLOWER

be protected against low water and the engine against high water.

For supplying the boiler with water a triplex single-acting power pump is one of the most economical pumps; as it is driven by a belt from the nearest shaft it utilizes the power of the main engine. If it is convenient to drive this pump directly from the crankshaft, it will be the best plan. It is not practicable to state in this article the size of pump that will be required and the speed at which it should be operated. The manufacturers will give these directions, if the grate area is given, also the weight of coal burned per hour. A general rule for this purpose is to allow one gallon of water for each pound of coal burned.

This type of pump usually runs at a constant speed, but the quantity of water delivered may be regulated by connecting a bypass between the discharge and suction sides of the pump. Put a globe valve in this bypass, and by regulating it a part of the water circulates around the pump while the larger part goes to the boiler. If the suction and delivery are 1½ in., make the bypass ½ in.

If the water available is of good quality for making steam, it may be pumped through a closed feed-water heater which will raise its temperature to about 210 deg. F. Water that contains scale-making impurities may be used with safety if an open feed-water heater is installed to purify it.

For a plant of this size a 12x24-in. Corliss engine running at 100 r.p.m. will give good service. For larger plants a unaflow engine would be more economical, and for some conditions a turbine should be used, but for ordinary service in the small plants the Corliss is, in my opinion, the best machine to purchase.

The type of transmission machinery will depend on conditions. The generator may be direct connected or belt driven, and this unit will furnish power to the motors in various parts of the mill. Where power must be delivered 100 ft. or more from the engine, this is the best. However, there is a loss in the generator and more in the motors, therefore the loss thus shown will drive shafting of reasonable length and give satisfactory results. If all or nearly all of the machines to be driven, can be located near the engine, the most economical and simple method is to use belts and short shafts.

The steam line to the engine should have a separator to insure only dry steam being delivered to the engine, and to prevent the wrecking of the engine by water in case the water level is accidentally raised too high in the boiler.

The exhaust line should also be fitted with a separator to remove the oil if the steam is to be used for heating or other purposes.

After steam has been condensed in the heating and drying processes, the returns should flow into an automatic receiver, from which it is taken by a pump and put back into the boiler. This arrangement is shown in Fig. 3. The exhaust from this pump should discharge into the main exhaust pipe, so as to deliver its steam through the separator with that from the main engine. Where water under pressure is available, a small pipe may be connected into this receiver to supply the necessary makeup water. This water should be passed through the heater to avoid the possibility of cold water being pumped into the boiler.

If there is not sufficient exhaust steam to supply the demand, it may be supplemented by live steam. This steam should be passed through a reducing valve and the pressure reduced to two or three pounds.

If the engine is belted to a generator to produce current for the motors, the mill or shop may be lighted

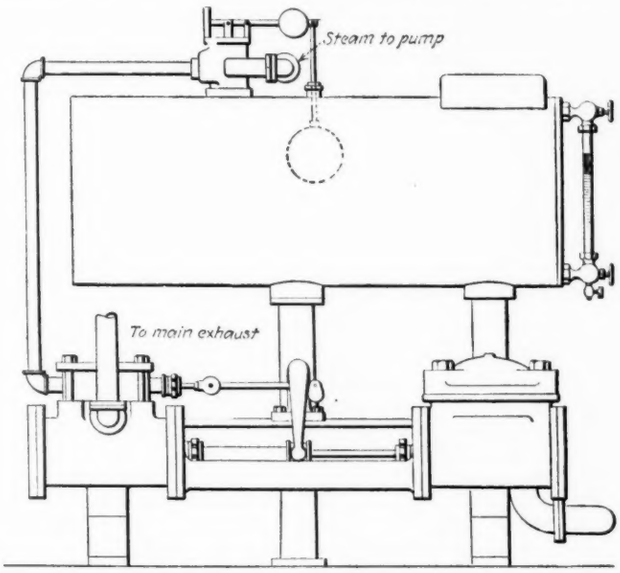


FIG. 3—ARRANGEMENT OF RECEIVER AND FEED PUMP WITH AUTOMATIC CONTROL

from the same source. Where belts and shafting are employed to transmit power, a suitable generator should be installed for lighting, and driven from a convenient shaft. If a heavy load is thrown on or off, it may affect the lights momentarily, but not enough to be objectionable under stated conditions. It is the cheapest possible way to secure the necessary illumination.

New Haven, Conn. W. H. WAKEMAN.

COMMENTS from READERS

Efficiency of Unaflow Engines

I read with a great deal of interest the article "The Efficiency of Unaflow Engines," by A. D. Skinner in the Aug. 29 issue. To the views expressed by Mr. Skinner I think every engineer will assent. I am surprised, however, that there should be so much worry over the leaky-valve question when the solution is so simple, viz., the single-seat poppet valve. In an article published in the Aug. 16, 1921, issue of *Power* the writer endeavored to show that there was no diffculty in operating valves of this type in steam engines, and that by employing the vena-contracta principle, the sizes of valves could be reduced.

Another detail that does not appear to receive adequate attention is the heat insulation of the cylinder. There is room for some gain in economy in this direction. CHARLES HURST.

Dallas, Tex.

Removing Broken Stud Bolts

In the Aug. 29 issue H. J. Scannell suggests the removing of broken stud bolts by using an "easy out." Studs of small size can be removed in this way without difficulty, but with studs ¾ in. or above the task is not so simple, as the "easy-out" will simply ream out the drilled hole. It has been my experience that if a square punch, driven into the hole, will not remove the stud, it will have to be chiseled out.

Some time ago two studs were broken on an outside center-packed plunger pump and could not be started with a chisel or set, so it was necessary to make a short ratchet about 6 in. over all and drill out the stud ends. This took considerable time. In order to prevent similar delay in the future, I removed the ¾-in. dia. stuffing-box studs from this and three similar pumps and drilled in each a ⅝-in. hole about two inches deep into the short end that screws into the pump. Now, when a stud breaks, it is only necessary to drive a ⅝-in. square tool-bit stock ground tapering, into the ⅝-in. hole and the stud is readily removed and replaced.

Elmira, N. Y. WALTER WOLGAST.

New Location for Fusible Plug

The article on "New Location for Fusible Plug," in the Aug. 29 issue, brings up the old question, Does it comply with the state boiler rules, or is the boiler on which it is used exempt from state inspection?

Previous to 1908, the year in which the Massachusetts Boiler Rules became effective, it was common to find in a certain type of water-tube boiler a fusible plug, or low-water alarm, similar to that described by Mr. Chandler. A small pipe passed through the top of the steam drum and extended to within a few inches of the bottom of the drum. Outside the drum a valve was connected to the pipe and directly above this a plug of fusible metal followed by a whistle. When the water in the drum dropped below the end of the internal pipe, the steam would fuse the plug and blow the alarm whistle.

Upon the adoption of the Boiler Rules the alarm was condemned for the reason that there was a valve between the boiler and the plug.

The letter states that in the Springfield boiler the valve between the water column and the plug is sealed open. Now in Massachusetts it is necessary for a man in charge of a steam plant to keep a record of the blowing down of the column in a book furnished by the state and examined from time to time by the state inspector. He is required to blow the column down twice each day for the sake of record and as many more times as he may consider it necessary. Does the man in charge of the Springfield boiler break the seal and close the valve every time he blows the column and then re-seal the valve open again? C. J. CRAFFEY.

Watertown, Mass.

Comparative Tests on Coal and Oil

With reference to D. F. Grahame's letter, "Weak Points in Comparison of Coal and Oil," in the July 4 issue, it would appear from the figures presented that the efficiency under oil is lower than should be typical. In the last two months we have run twenty tests on boilers where a change has been made from coal to oil, and in all cases we have run an average of 80 per cent efficiency. Our low figure was 76.4 per cent where the furnace had not been properly changed to suit oil burning and where the burners were only 20 in. below the shell. In any case the changes we have made have been slight.

The coal efficiency given appears reasonable, and I doubt whether an evaporation of 8 lb., such as would be necessary to give 60 per cent efficiency with 13,000-B.t.u. coal, is obtained in the average manufacturing plant.

Many operating men say they obtain an evaporation of 8 lb. of water per pound of coal when you ask them, but in most plants they have no means of checking the result. In some cases the water discharged in blowing down the boilers has been credited to the plant as evaporation.

From records in our office the coal costs at Toronto for the five years' average 1915-20 have been $7.50 a

ton for 13,000 to 14,000-B.t.u. coal with an ash content of from 10 to 15 per cent.

Oil saves in labor, loss in ash, unburned fuel that goes up the stack, heating of ash to furnace temperature and incomplete combustion. Less storage space is needed and more easily provided and at less cost. The labor item and maintenance show the largest savings.

If an engineer experienced in oil burning is employed to design the furnace, excellent results can be obtained and such money as is paid for his advice will be repaid many times over. ALBERT A. KRAL.

Chicago, Ill.

Why the Consulting Engineer Should Design the Power Plant

There has been considerable discussion from time to time as to the advisability of engaging the services of a consulting engineer when making additions or designing a new plant.

Building a power plant is a study in engineering and in economics, and the designer should have liberal engineering knowledge and experience, for good designs are the result of research, study, experience and business judgment.

Large public utilities, some railroads, steel companies and some of the larger industrial plants have within their organizations, the engineering talent and experience to enable them to design their own power plants. The smaller utilities and the average industrial companies have no such organization, and attempts to build power plants may, and frequently do, result in designs not suitable to the industry which they are to serve, or the conditions under which they must operate, and often entail losses due to low efficiency or low economy.

Standard designs of power stations have been proposed. This is not possible of application without the most expert advice. No two sets of conditions are identical, and the design suitable for one case might be entirely unsuitable for another. In the matter of stokers alone a difference of 200 miles in location may necessitate a different type for assurance even of continuous operation, to say nothing of efficiencies.

Another common practice is to follow the local standards in selection of equipment. This may be a good plan in some cases, but too often it simply means repeating mistakes, with no logical reasons for the selection.

Various equipment companies are willing and able to perform all engineering services in connection with their equipment, but it must be realized that their opinions are usually biased by the equipment they have to offer. Too often the ardor of the salesman exceeds his judgment, and as a result power-station designs are governed largely by the equipment he has for sale.

The logical solution to such problems is to engage the services of a consulting engineer. His training and that of his organization enable them to analyze engineering problems. Experience in scores of cases affords a basis of judgment regarding the equipment to be selected and the firms best suited to supply such equipment.

There are so many things that can make a plant a success or a failure that the attempt to build without full knowledge and experience is to run a strong risk of error either in selection of the best equipment for the service or in its arrangement in the station as a whole.

To design economical power plants requires study and experience. Sometimes the cheapest equipment is the best; sometimes it is the most expensive. Arrangement, location and application are frequently as important as the actual selection of the equipment. As an example, scores of stoker installations have been disappointing, due, not to the stoker itself, but frequently to low draft caused by an inadequate chimney or breeching or improperly designed ashpits. The same thing may also be true of the boilers and the other plant equipment.

Business judgment must accompany engineering. Problems must be treated, not in an abstract manner, but in their relation to the plant and the works as a whole. For instance, almost any one can design a chimney to meet certain conditions of load, coal and temperature, but it requires experience to foresee the possible variations in the fuel market, the possible operating conditions of load and temperatures and the draft that may be required. Then there is the broader problem of possible plant expansion. Should a chimney be designed for present needs or for a five- or ten-year growth, and how extensive will this be?

There are problems involving a study of test results as compared to average operating results; of capacity or efficiency obtained at the expense of reliability or maintenance; and of efficiencies which are not real economies due to offsetting capital, operating and maintenance charges. Business judgment in engineering is of equal importance with technical training and experience.

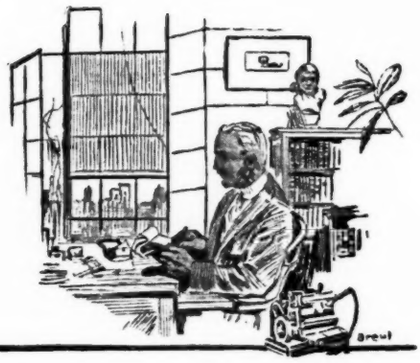
Most industrial organizations build a power plant once in fifteen years. Consulting engineers are working on similar problems continuously. This is a good reason why they should be more competent to build power stations than engineers engaged in industrial lines. The consulting engineer is in a position to keep up with standard practice. He is familiar with the current cost of equipment and with those sources best able to design and install equipment to meet certain specific demands. This information is of such a nature that it is impossible for the industrial company or anyone not dealing continuously with such matters to become conversant with it by buying one, or even two or three power plants.

Mistakes that are made in designs remain with the plant throughout its life. A small mistake in the breeching may result in decreased capacity so long as the plant exists. An improper ashpit may result in high maintenance or the use of an extra man at all times. Sometimes the selection of equipment is such that certain coals cannot be used. Under such a condition the company is saddled for the life of the plant with a high operating cost. Mistakes such as these do not appear in the calculations and figures which are prepared in order to obtain the appropriation for the plant, nor are they apparent to the average man when inspecting the plant. They are, nevertheless, the points of design which really create the difference between success and failure.

With a period of keen competition confronting this country, one of the best investments will be the money spent by industrial organizations in employing competent consulting engineers to design their power plants. This money will save fuel and operating expense and earn money for the payment of dividends.

Chicago, Ill. T. A. MARSH,
Chief Engineer, Green Engineering Co.

QUESTIONS AND ANSWERS



Designation of Sides of Duplex Pump

What determines the designations of "right-hand" or "left-hand" side of a duplex pump? A. S. M.

According to the usual method of designation, when the observer stands at the steam end and faces toward the water end, the side of the pump on his left is the left-hand side (L. H.) and side on his right is the right-hand side (R. H.).

Reason for Lap of Corliss Steam Valves

Why is lap given to the steam valves of a single-eccentric Corliss engine? N. D.

It is desirable to obtain early release of the steam after expansion and early enough closure of the exhaust valves to obtain cushioning of the piston by compression of the exhaust. This requires that the eccentric which operates the exhaust valves shall be set more than 90 degrees ahead of the crank. With a single eccentric for operating both steam and exhaust valves, without lap on the steam valves, they would open more than necessary for the proper lead before the crank arrived at dead center for the beginning of a stroke of the piston. Hence the lap is added to the steam valves to delay their opening until the proper time for admission of steam with the desired amount of lead.

Steam-Cylinder Clearance of Direct-Acting Pumps

Why are cylinders of direct-acting steam pumps provided with so much greater clearance than the cylinders of ordinary steam engines? C. W. T.

For a direct-acting steam pump it is dangerous to allow the piston to travel as near the cylinder heads as in the ordinary engine, since a slight change in the conditions of steam pressure, pump friction or the pressure pumped against, might cause the piston to strike the cylinder head. Hence ample piston-travel clearance must be provided, because the amount of travel that will be obtained cannot be fixed as in an engine with a crank and connecting rod, and consequently there must be a larger percentage of clearance volume.

Taking up Slackness of Boiler Stays

How is the slackness of boiler stays taken up? H. L.

When the stays are through stays extending from head to head of a cylindrical boiler, the ends of the stays are threaded with nuts inside and outside of the boiler and any slackening of such a stay is taken up at one end by backing off the inside nut, taking up the outside nut and resetting the inside nut. When the stays are connected by pins to crow-foot or angle-iron eyes, the slackness can be taken out by providing a broader pin that will draw the stay tight if inserted while the stay is expanded in length by the heat of a torch. When solid diagonal braces are to be tightened, the rivets holding the stay to the shell should be cut out, and while the slackness is taken up by a drift pin passed through one of the rivet holes, the other holes should be alternately bolted, reamed true and filled with new rivets, finally removing the drift pin, reaming the remaining hole and filling it with a rivet.

Noise in Crank End When Starting Engine

When starting up our mill engine in the morning, there is in the crank end a grunting noise that lasts for a few minutes, but by the time the engine is up to speed with a steady load, the noise stops. What is the explanation? J. A. F.

The irregular resistance when starting up the engine under the load of shafting and, probably also of laying on of machinery, combined with the ununiform turning effort of the engine, give rise to vibrations of the engine shaft that are transmitted to the main bearing and, more or less, to other parts of the engine.

When the engine gets up to speed, the vibrations become smoothed out and the loud noise ceases because irregularities of the load resistance and the varying turning effort of the engine are overcome by inertia of the shafting and machinery of the mill and by inertia of the flywheel of the engine.

Pressure Attainable by Raising Steam with Steam Space Filled with Air

If a boiler is standing cold at a temperature of 70 deg. F. with the steam space filled with air at atmospheric pressure, and steam is raised without bleeding the air until the temperature in the steam space is 382 deg. F., what will be the reading of the steam gage, assuming that no air is absorbed by the water? G. B. P.

The pressure in the steam space will be the pressure of water vapor due to the temperature, 382 deg. F., which is 200 lb. per sq.in. absolute plus the pressure attained by raising the air to that temperature from the initial atmospheric pressure.

Neglecting the small amount of initial pressure due to the presence of water vapor, and assuming the initial air tension to be 14.7 lb. per sq.in. absolute, the air raised from 70 to 382 deg. F., that is, from 76 + 460 = 530 deg. absolute to 382 + 460 = 842 deg. absolute.

would attain a separate pressure of 842 ÷ 530 × 14.7 = 23.3 lb. per sq.in. absolute; and without bleeding or relief by the safety valve, the pressure would be 23.3 + 200 = 223.3 lb. per sq.in. absolute, or 223.3 — 14.7 = 208.6 lb. per sq.in. gage pressure.

No Advantage to Lower Pump

A 12 x 10 x 12-in. duplex pump is used for raising water from five wells that are connected to a common suction by branches that have an average length of about 175 ft. The wells are located on level ground, and the water is at the same level in all the wells. Could not a higher suction lift be obtained if the pump is lowered without changing the suction lines? A. L. E.

No advantage could be gained from lowering the pump without also lowering the suction pipes. To raise the water by suction to the present level of the suction line and branches would require the same vacuum, and there would be the same liberation of air out of the water and leakage of air through the joints of the suction pipes. This air, now taken care of by the pump, would cause the suction pipes at higher level than the pump to become airbound and render the system inoperative.

No Benefit from Superior Engine Economy if Whole of Exhaust Heat is Utilized

In operating a 75-kw. engine supplied with steam at 100 lb. gage and using the exhaust for heating purposes, how would the economy of the plant be affected by raising the boiler pressure to 125 lb. gage? R. N. D.

For the same load and back pressure the cutoff of the engine would be earlier, and under usual conditions less fuel would be required for generation of steam required by the engine. However, development of the same number of horsepower would abstract the same amount of heat from the steam and there would be less heat available from the exhaust. Hence, if the improvement of engine economy should be accompanied by a deficiency of steam required for heating that has to be made up in live steam, increasing the initial pressure with improvement of engine economy would be of no benefit to the general economy of the plant. On the other hand, any improvement in engine economy would be beneficial at any time when all the exhaust cannot be utilized.

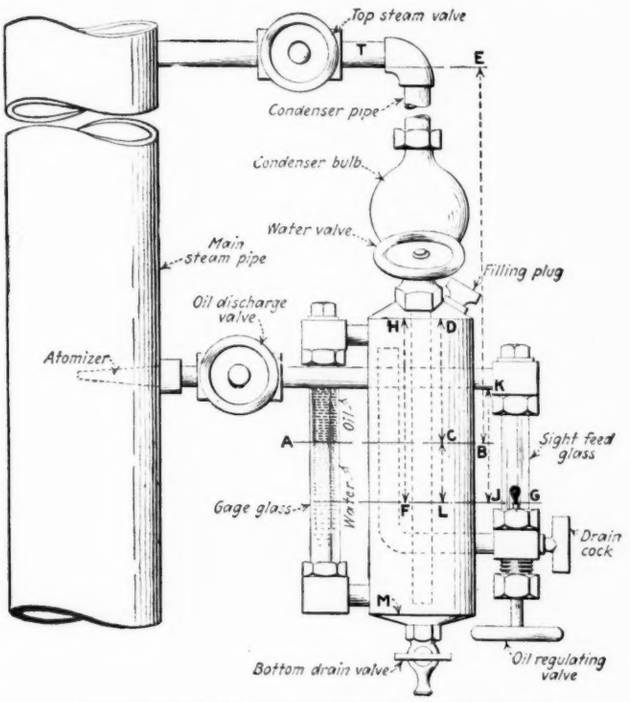
Discharge of Hydrostatic Lubricator

At what point of water level in the oil chamber will a hydrostatic steam-cylinder lubricator feed cylinder oil fastest for a given amount of opening of the oil-regulating valve? W. L. M.

For an ordinary form of lubricator with connections as illustrated in the figure, the lower the water level in the main oil chamber the higher the net pressure that urges the oil through the aperture controlled by the regulating valve. Suppose *AB* is the level of water in the oil chamber, with *CD* the height of oil in the oil chamber; *BE* the height of water in the condenser above *AB; FG* the level of the discharge aperture of the oil-regulating valve; *FH* the height of the upper surface of the oil above the level *FG;* and *JK* the height of water in the connection of the sight-feed glass, measured from *FG* to the level of water in the oil-discharge pipe at *K*.

Then the pressure of oil on the under side of the aperture at *G* would be, main steam-pipe pressure entering at top steam valve *T* + water-column pressure *EB* — oil pressure due to height *CD* + oil pressure due to height *FH*. But as *CL* equals *FH* — *CD*, the pressure of oil presented to the aperture would be, main steam-pipe pressure + water column *EB* + head of oil *CL*. The resistance to discharge of oil to the steam-pipe connection *K* would be the pressure required for overcoming friction of flow through the aperture at *G*, plus the counter-pressure due to the sight-feed-glass water column *JK*, plus the main steam-pipe pressure at *K*.

The counter-head *JK* is constant, and the oil discharge through the aperture would increase with the net pressure on the lubricator side of the aperture at *G;* and for the water level *AB* the net pressure would



DISCHARGE OF HYDROSTATIC LUBRICATOR

be the water-column pressure *BE* — water-column pressure *JK* + head of oil *CL*.

The lower the water level *AB* the greater the water-column pressure *BE*, but the less the assistance of an oil-pressure head *CL*. However, as the gravity of the oil is less than that of water, there will be greater pressure acting on the aperture of the regulating valve from the same increase of water column *EB* as the decrease of the net oil head *CL;* hence there will be greater pressure on the lubricator side of the aperture for the water level at *FG* than for a higher water level as at *AB*, with less oil in the main oil chamber. The greatest pressure on the aperture, and consequently the most rapid discharge of oil, would occur through a given aperture at *G* when the oil chamber is filled with oil and the water level is at the bottom *M*, as the water-column pressure then would be increased by the depth of *M* below the level *FG* and decreased by a less hydrostatic pressure of an equal height of oil.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

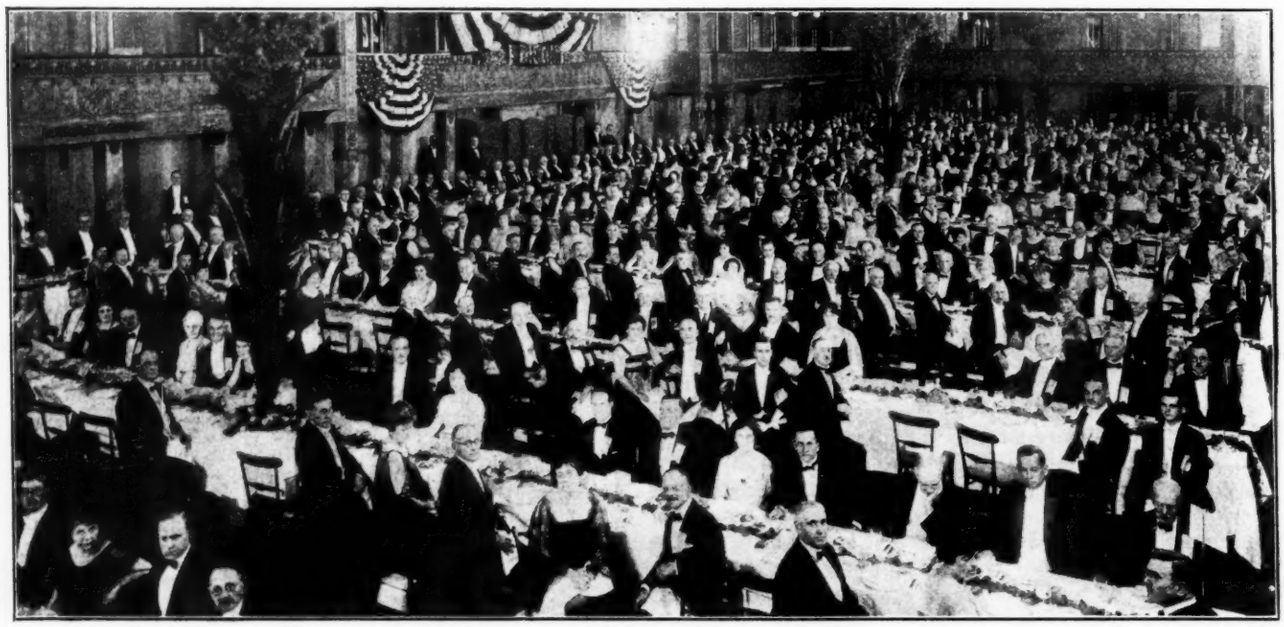
Thomas A. Edison Honored by Central-Station Men

A testimonial dinner was tendered Thomas A. Edison by the New York Edison Company on Monday evening, Sept. 11, at the Hotel Commodore, New York, to commemorate the fortieth anniversary of the central-station industry and the part taken by the great inventor in making possible the growth of this industry. About seven hundred guests were present, including many outstanding figures in public-utilities affairs, prominent engineers and educators, and a number who had been associated with Mr. Edison in his pioneer undertakings. Among the latter were J. W. Lieb, now vice-president of the New York Edison Company, who was electrician for Edison at the time the old Pearl Street station was started, and also Samuel Insull, president of the Commonwealth Edison Company, Chicago, who in the early days was private secretary to Mr. Edison. Mr. Insull told of his first meeting with Edison; how as a young man he had been employed by the latter's English representative and had come to this country to become the inventor's private secretary. Arriving at New York on the steamer at 5 p.m., he had been met by Mr. Edison and after a hasty meal the two had sat up all night discussing the problems of the company. He told of some of the early struggles to finance the undertakings on this side and how Mr. Edison had placed behind them his entire personal wealth.

In order to start a central-station service in New York City, Edison had also to start several establishments to manufacture the equipment needed, especially the underground conductors. Mr. Insull sketched the growth of the industry from the days of the Pearl Street station, with its fifty-nine customers, to the present and made the statement that over four and one-half billion dollars is now invested in the electric-light industry throughout the country. The expenditure for new equipment is at the rate of a million and a quarter a day.

Mr. Lieb told how Edison had come to take up the incandescent lamp.: In those days (1882) the only electric lights were arc lamps, and it was Edison's dream to bring out a substitute that could be presented in smaller units for use in the home and the shop and thus compete with gas. In order to cut down the size of the conductors, he recognized from the first that it would be necessary that the lamps have a high resistance and small radiating surface. The standard lamp voltage was placed at 110 volts, and it is significant that this still holds. The speaker sketched the equipment in the original Pearl Street station and showed how in many fundamental respects it had set the standard for present central-station practice, although at that time there was not an ammeter or a voltmeter in the station. The load in the New York Edison Company has now grown to a maximum of 450,000 kw. and, according to Mr. Lieb, such has been the development in central-station economies that a pound of coal now produces twenty-five times the illumination that was produced by the first station. The remarkable fact was that the old Pearl Street station and the underground system of distribution was a commercial success from the start.

Speaking for the City of New York, Murray Hulbert, President of the Board of Aldermen and acting Mayor, presented Mr. Edison with a key symbolizing the freedom of the city. In accepting this, Mr. Edison replied in a written speech, read by his son, in which he characterized the old Pearl Street station as the greatest adventure of his life. Much of his success he attributed to the faithful co-operation of his associates.



MR. EDISON IS SEATED AT THE CENTER OF THE SPEAKER'S TABLE

Other speakers included Nicholas F. Brady, toastmaster, and Frederick Fish, formerly president of the American Telephone and Telegraph Company.

During the evening demonstrations were given with some of Mr. Edison's early lamps and also a 1,000-candlepower light said to be the most brilliant lamp in existence.

It is often desirable to determine without exposing a valuable instrument to possible corrosion whether a solvent is useful or not, states the United States Bureau of Mines. For this purpose a soft steel plate may be brightened with emery paper and rubbed with potassium chloride. The oil or solvent should then be used as directed with special care not to dislodge mechanically the salt from direct contact with the steel. The plate should then be exposed to a saturated humidity for not less than a week. Only those processes that give complete protection should be employed.

At least 10 per cent of the applications before the Federal Power Commission are affected by the Commission's new policy of not accepting a second application from individuals or corporations who had not shown financial ability to carry out the project on the previous application, provided no added showing as to financial backing could be put forward.

A. I. & S. E. E. Discusses Power Problems at Annual Convention

BEGINNING on Sept. 11 and extending through the week to Friday, the 15th, the Association of Iron & Steel Electrical Engineers held its sixteenth annual convention in the Cleveland Public Hall, Cleveland, Ohio. A total of eight technical sessions were held, at which fourteen papers and nine technical committee reports were presented and discussed. The first technical session was held on Monday afternoon and was devoted to a presentation and discussion of the committee and subcommittee reports, President W. S. Hall occupying the chair.

How important electric drive has become to the iron and steel industry is clearly indicated in the Report on Electrical Development. During the first half of the past year, operations in this industry were considerably below normal, and electrical developments were confined, in a large degree, to matters which did not require any considerable amount of financing, covering minor details that had for their object the lowering of the cost of production. Notwithstanding this fact there were installed or placed on order in the country thirty-three electrical equipments for driving different types of rolling mills. These drives varied in size from a 6,500 hp. continuous rating and 11,500 hp. maximum rating down to 500 hp. In addition to these, orders were received from France and England for 5 equipments varying in size from 5,750 hp. to 1,500 hp. At least four of the largest equipments installed or ordered in this country are to replace steam engines. These equipments indicate that there is a tendency to use direct-current motors supplied with power from motor-generators or rotary converters, in preference to one of the several successful schemes for obtaining adjustable speed by means of auxiliary equipment used in connection with wound-rotor motors.

In the report attention is called to the alternating-current brush-shifting adjustable-speed motor, which although developed and applied some years ago has just recently begun to receive that prominence to which it is justly entitled. Its particular field of application is in driving variable speed loads of high load factor where the efficiency of operation is of importance, as in the case of general draft fan, pump, etc., applications. It is well adapted to driving power house auxiliaries, as for examples, forced and induced draft fans. Compared with a slip ring induction motor with secondary rheostat control, the brush shifting motor shows marked superiority in efficiency at reduced speeds. At half speed, the brush shifting motor will have an efficiency of approximately 67 per cent, while the induction motor efficiency will be nearer 40 per cent.

Power House Equipment

There has been a continuous effort on the part of power house designers and manufacturers of the apparatus used therein to improve the method and means of electric energy production. Increase in plant thermal efficiency has been obtained through a reduction of radiation, leakage and so-called "unaccounted for" losses as well as those incident to a poor station heat balance, through a more carefully planned plant layout, more compact and better grouping of apparatus and employment of means to obtain an economical heat balance throughout the operating range of the station. Important as these means have been in increasing station economies, they are probably overshadowed by two more fundamental ones, namely, an increase in prime mover thermal economy and an increase in the range of the heat cycle.

In the case of the larger installations, high pressure superheated steam at temperatures as high as 700 deg. F. (as for example, 350 lb. gage pressure, 260 deg. F. superheat) can now be successfully employed for power generation. In the smaller plants, where it is desirable to seek high thermal economy, temperatures of 625 deg. F. can be conservatively recommended.

Recently there have been placed in operation three 10,000-kw. turbines in steel plants, one at the Inland Steel Company, another at the Lebanon plant of the Bethlehem Steel Company, and the third at the American Rolling Mill Company. The largest single unit operating in any plant of the industry is the 20,000-kw., 100 per cent pf. (17,000 kw., 85 per cent pf.) turbo-generator in the plant of the Jones & Laughlin Steel Company at Woodlawn, Pa.

The motors committee sent out a questionnaire on the use of anti-friction bearings to the electrical engineers in 25 of the largest steel plants. The average results of this questionnaire were:

	A.C. Motors	D.C. Motors
Burnouts due to overheating	8	6
Breakdowns due to insulation failure, Caused by		
Oil	37	41
Moisture	5	15
Outside influence	34	17
Breakdowns due to mechanical failures	16	21
Total	100%	100%

This tabulation shows the high percentage of motor failures due to oil. This, therefore, is the first trouble we should try to eliminate.

The general remarks which accompanied the questionnaire are of unusual interest. One plant reported that 75 per cent of failures caused by oil could be eliminated if ball or roller bearings in which grease was used as a lubricant replaced the ring oiler bearings. This plant also reported a number of large motors as well as some small motors equipped with ball bearings as having no failures in the past two years. Another plant reports 95 per cent of oil failures could be eliminated by ball or roller bearings.

Such comments as these indicate that the steel mill electrical engineers cannot go into the question of anti-friction bearings with full confidence in their ability to withstand severe duty, and it is the recommendation of this committee that the bearing manufacturers be requested to line up standard anti-friction bearings so that bearings for given size shafts will be interchangeable from one line of motors to another.

Report of Control Committee

The report of the control committee showed that the membership of the Association was in favor of control standardization. There is some difference of opinion as to how far this standardization should be carried and what parts should be given first consideration, but the fact remains that there is a great demand for standard parts. A further proof of this can be found in the fact that many steel companies have standardized on a certain make of resistance grids or a certain make of control boards and refuse to consider propositions on apparatus from other firms. The reason for doing this is to reduce the spare parts that have to be carried in stock for repairs and to reduce the large amount of capital tied up in such stock. If there was any good reason for the hundreds of different resistance boxes now forced upon the users, the steel companies would not be taking this matter into their own hands.

In the discussion of a paper on "Generating Station Development," by David B. Rushmore and E. Pragst, it was brought out that five of the 5,000-hp. generators, designed in 1893 for Niagara Falls, had been rewound to generate 11,000 volts 3-phase instead of 2,200 volts 2-phase. In making this change it was possible to reduce the electrical losses in the machines from 350 hp. to 150 hp. which resulted in an improvement of 4½ per cent in efficiency.

There was considerable interest evidenced in the Lungstrum steam turbine, and in answer to questions regarding the possibilities of this machine as an efficient prime mover, Mr. Rushmore said it was a matter of common knowledge that the General Electric Co. had obtained the American rights to the patents on this machine. However, up to the present his company had been able to get better results with its present design of turbines than with the Lungstrum

machine. Due to structural features of the Lungstrum turbine it is difficult to construct it in large sizes. It was the speaker's opinion that although machines up to 5,000-kw. capacity had been built and put into operation in Europe, this type of turbine has its greatest possibilities in increasing the efficiency of small size units. The opinion was expressed that all the commercial means available for generating electrical power were making great advancements and that it would be necessary for the large plants to improve their efficiency if they were not going to find serious competition in the smaller plants equipped with internal combustion engines, or other efficient small prime movers. Power will be cheaper in the future than it is now, due to improvement in design even with the increased cost of fuel.

In the large steel mill power plant it was considered possible to produce a kilowatt-hour on from 20,000 to 21,000 B.t.u., whereas in the largest and most efficient central stations these figures are down to 18,000 to 19,000 B.t.u.

Several interesting papers were presented on steam boiler practice, abstracts of which follow:

Trend of Boiler Development

In discussing the relative cost of large and small boilers per horsepower, J. B. Crane, engineer with Geo. T. Ladd Company, said that from 500 to 1,500 or 1,800 hp. there is a gradually decreasing cost per horsepower. The same tube surface and drum surface per horsepower is required, but no more castings, water columns, etc., are required for the larger boiler. However, above this size two of the smaller boilers are put together in a battery facing each other instead of side by side, and circulating tubes, etc., are necessary, which makes the total cost per horsepower take a slight jump. The advantages in going to larger boilers are less floor space, which means less foundations, less buildings, also less piping and fittings, less valves, less instruments, and a more complete outfit.

The pressure in the industrial field seems to be standardizing at 250 and 275 lb., while the public utility field has gone to 350 lb. in three or four instances; to 475 lb. in one English company; and to 400 lb. in the case of one French company; the tendency being to hover around 300 lb. The idea is to stay around a total steam temperature of 650 to 700 deg., but whether it is better to go to a high pressure and low superheat or lower pressure and high superheat finds warm advocates for each side.

Mr. Crane recommended that the furnace be designed so that the brickwork in the hot zone does not have to support more than 25 lb. per square inch, that the inside walls be inclined away from the fire, three to four feet of combustion space be allowed per rated horsepower and as much of the boiler surface be exposed to the combustion chamber as possible. Brick troubles will then practically disappear.

Boiler Practices of 1922

This subject was discussed by R. E. Butler of the Babcock & Wilcox Co., who said that in order to obtain higher efficiency from the boiler unit itself, more heating surface is being installed per foot of furnace width. For example, in the Babcock & Wilcox type for direct coal firing, boilers have been installed 18 to 20 tubes high. This results in a lower exit gas temperature and greater efficiency.

For the absorption of heat from blast furnace gas or the waste gases from metallurgical furnaces, it is necessary to install materially more heating surface per foot of furnace width than with direct coal fired boilers. This is necessary in order to secure high enough gas velocities to give good heat absorption and resulting high efficiency. Boilers of the Babcock & Wilcox type are built 20 to 27 tubes in height for this service. It has been general practice in this field to install boilers without economizers rather than boilers of less heating surface with economizers, due to space conditions or return on the investment in economizers.

The advantages of mechanical operation have led recently to experiments and investigations in the burning of coal on forced blast chain grate stokers, and in a powdered state, blown into the furnace. It would appear that the blast chain grate stoker is particularly adapted to the lower grades of coal and coke braize. This type of stoker usually varies in length from 15 to 20 ft., and there are a number in successful operation today as wide as 24 ft. Blast chain grates of 27 to 30 ft. in width are under consideration for several plants. Whether or not this type of stoker will be used to any extent for burning the average and better grades of fuel remains yet to be seen.

Modern Sectional Header Boiler

R. M. Rush, of the Springfield Boiler Co., said that until the successful development of the electric furnace it was necessary to depend upon ordinary steel castings, or upon pressed and welded steel tubes for headers. With the advent of high steam pressure and the high temperatures which come with heavy overloads, ordinary steel castings were not good enough and the pressed steel header, with its welded joint at the bottom, was not always satisfactory.

The boiler makers then turned to the electric steel industry for something better. The following test report of a heat for headers which went into the construction of some large boilers in New York City shows the quality of steel obtainable.

Silicon	0.28	Elastic limit	35,050 lbs. sq. in.
Sulphur	0.048	Tensile strength	74,700 lbs. sq. in.
Phosphorus	0.018	Elongation	25.0 per cent
Manganese	0.63	Reduction of area	31.0 per cent
Combined carbon	0.34	Fracture	½ cup
Graphitic carbon	....	Bend	100 deg.

E. R. Fish and Alfred Cotton, both of the Heine Boiler Co., in a paper on "Heine Boiler Practice in 1922" emphasized the demand for large combustion chambers and thorough mixture of the gases. Horizontal baffling provides these with moderate setting heights because the combustion chamber occupies the whole length of the setting and the vertical and horizontal paths insure thorough gas mixture.

Boiler Welding

The welding of pressure parts of boilers also attracted usual interest. It was pointed out that in some cases where riveted lap joints had been welded along the edge of the plate these welds had cracked. Also there was no suitable method of testing the welds and since the condition of the joint depended largely upon the operator, the insurance companies had been reluctant to insure welded boilers. Extensive research work is now under way that is expected to overcome the present objections.

It was brought out that one of the boilers at the Ford River Rouge plant had been in operation for six months, burning oil, tar, powdered coal and gas, and operating at over 200 per cent rating. This boiler when taken out of service at the end of this time was found to be in good condition, and might have continued in operation for six months longer, without requiring taking out of service for inspection and cleaning.

Internal Combustion Engines Discussed

"Internal Combustion Engines for Power Generation in Steel Plants" was the subject of a paper by M. D. Petty, the Electrical Engineer of the South Bethlehem plant of the Bethlehem Steel Co., who said that the consequent difference in temperature between inner and outer surfaces of the cylinder wall induces heat fatigue and consequent cracks when engines are steadily operated at full load. A cast iron cylinder which thus cracks cannot be repaired by welding. A cast steel cylinder seldom cracks and if it does, can be electrically welded without difficulty. There are steel cylinders in the plant that have operated continuously thirteen years and are still perfectly good. A full abstract of this paper will appear in a later issue of *Power*. On the discussion that followed, Mr. Hampton added that at Gary, Ind., fifty-six gas engines are installed of which 10,400 hp. drives generators in parallel with two 7,500 kw. and two 2,200 kw. turbo-generators which absorb peak loads on the system. Gas engines are operated at their best efficiency and the turbines have taken the peaks for nearly eleven years. The supply has never suffered on account of gas engine trouble. There are gas engines which have run seven years without overhauling, although the general practice is to overhaul every five years. Operators are allowed

three minutes to synchronize, starting with the engine cold. In emergency this can be done in 1½ minutes. Some gas engines cylinders at Gary have been in service fourteen years.

J. R. McDermott advised that uses for blast furnace gas are being developed which make highest economy in its use for power of great importance no matter if there is surplus of gas for power. R. B. Gerhardt, recently in considering steam turbine installation for Sparrows Point, said that the cost of power production is considered on the basis of purchased fuel, since they had uses for all blast furnace gas. It was not a case of turbine versus gas engine but the need of both gas engine for economy and the turbine for regulation.

Officers Elected for 1923 Are

President, R. B. Gerhardt, Electrical Superintendent, Bethlehem Steel Company, Sparrows Point, Md.; First Vice-President, L. F. Galbraith, Electrical Superintendent, West Penn Steel Co., Brackenridge, Pa.; Second Vice-President, R. S. Shoemaker, Superintendent of Maintenance, American Rolling Mill Co., Middletown, Ohio; Directors, Geo. Schaeffer, Electrical Superintendent, Carpenter Steel Co., Reading, Pa.; A. L. Freret, Assistant Chief Electrical Engineer, Tennessee Coal, Iron & R.R. Co., Birmingham, Ala.; B. G. Beck, Electrical Engineer, American Sheet & Tin Plate Co., Gary, Ind.; E. H. Wentz, Electrical Superintendent, National Tube Co., Lorain, Ohio; Treasurer (re-elected), James Farrington, Electrical Superintendent, La Belle Iron Works, Stubenville, Ohio; Secretary (re-elected), John F. Kelly, Empire Building, Pittsburgh, Pa.

Control of Coal Prices and Investigation of the Industry Seems Assured

Declaration of a national emergency with respect to coal production, enlargement of the powers of the Interstate Commerce Commission and the appointment of a Federal Fuel Distributor, to deal with the emergency, are the principal provisions of the Cummins bill for price control and distribution of coal, passed Sept. 7 in the Senate and now in conference in the process of adjustment with the Winslow (House) bill on the same subject. Also in conference this week is the Borah bill to create a fact-finding commission, passed in the Senate on Sept. 8 with no amendments other than those offered by its author and covering essentially the same ground as the Winslow coal-commission bill. In neither case is any trouble in conference anticipated, since there are no essential points at issue in the two pairs of similar bills.

Provisions of the Cummins Bill

Varying dates of expiration form the chief difference between the House and Senate bills for price control and distribution. The former (the Winslow bill) would expire Jan. 1, 1924, while the latter (the Cummins bill) would be in effect for six months from the date of enactment.

The Cummins bill in its opening clause declares the existence of a national emergency which threatens to hamper governmental action, interfere with the mails and the railroads, and furnish opportunity for extortionate coal prices.

In its second section, the bill authorizes the Interstate Commerce Commission to issue priority orders, proclaim embargoes and take any other suitable measures in favor of or against any railroad, inland steamship line, person, region or corporation, so as to insure the most equitable distribution of coal and to prevent the sale of coal at unjust prices.

The third section creates a new governmental agency, the "Federal Fuel Distribution." The Federal Fuel Distributor, appointed by the President, shall investigate the extent of the coal shortage if any exists; he shall study the production and marketing of coal; he shall determine whether or not current prices are reasonable, and he shall determine who is and who is not entitled to priority in the distribution of coal. His reports and recommendations are to be submitted to the Interstate Commerce Commission for its guidance in carrying out the provisions of Section 2.

The fourth section empowers the Federal Fuel Distributor to make any rules and regulations, issue any orders, cooperate with any governmental department, create any agency and make any expenditures that may be necessary in carrying out his duties.

The fifth section declares the act to be in effect for the present emergency only, and in no event longer than six months from the date of its passage, and the sixth and last section appropriates $250,000, "or as much thereof as may be necessary," for carrying out effectively the provisions of the act.

Senator Dial of South Carolina obtained passage of an amendment to the Cummins bill, providing that coal contracts entered into before July 25 should not be subject to any regulations made by the Interstate Commerce Commission regarding the assignment of cars, provided the price asked at the mine was not over $2 a ton.

Provisions of the Borah Bill

The Senate bill (known as the Borah fact-finding bill) to create a United States Coal Commission differs from the House coal-commission bill (introduced by Representative Winslow) in that it provides for a commission of five members, while the Winslow bill sets the number at nine. Also, the Borah bill carries an appropriation of $100,000, while the Winslow bill provides for the use of three times this amount; the Borah bill includes instructions to report regarding standardization of mines, wages and working conditions, and regarding the advisability of nationalizing the mines or of governmental control of the industry—such instructions are lacking in the Winslow bill.

Following the settlement of the hard-coal strike, a provision was added to the bill by Senator Borah, directing a separate investigation of the anthracite industry, with a report to be submitted not later than July 1, 1924.

The Borah bill creates a fact-finding commission of five men, appointed by the President with the advice and consent of the Senate. Members of the Senate and House and, in fact, any persons holding office under the United States are declared ineligible. Persons connected with the coal industry are eligible—the choice or exclusion of such men is left with the President. The salary of the commissioners is set at $7,500 a year, and the life of the commission is limited to one year from the date of passage of the act, unless otherwise provided by Congress.

The duties of the commission are identical with those outlined in the original Borah bill (see *Power* for Aug. 8, page 225). A report is to be submitted within five months, covering ownership and title of the mines, cost of production, profits realized by coal operators during the last ten years, labor costs, wages paid, possible remedies for present irregular production and causes of periodic coal strikes.

Recommendations must also be submitted regarding (a) standardizing the mines upon the basis of productive capacity (and regarding the closing down of mines that fall below the standard); (b) standardization of the cost of living for mine workers and of reasonable living conditions; (c) standardizing also as far as practicable the amount of work a man shall perform for a reasonable wage, recognizing the effect of living conditions upon efficiency; (d) standardizing a basis of arriving at the overhead cost of producing and distributing coal; (e) the advisability or wisdom of nationalizing the coal industry, and (f) the feasibility or necessity of governmental regulation and control of the industry.

The commission is given the power to require the production of any documentary evidence from any part of the United States, and to require the deposition of any person possessing information needed as evidence by the commission. Any member of the commission may administer oaths and examine witnesses. Penalties are provided for noncompliance with the provisions of this section of the bill.

The commission is given the power to appoint such employees as it may need and to fix the compensation of such employees, as well as to make such expenditures as may be needed in carrying out its duties. As before stated, the sum of $100,000 is appropriated from the treasury, to be available until one year after the passage of the act.

N.A.S.E. Holds Annual Convention at Des Moines

WITH the brand of hospitality for which Iowa is noted, Des Moines, capital of the great corn state, entertained for the first time in its history the National Association of Stationary Engineers, assembled for the fortieth annual convention, from Monday to Friday, Sept. 11-15. From start to finish the convention was well planned, thanks to the co-operation of capable national officers, the local convention committee and the Des Moines Chamber of Commerce. Its success was in no small measure contributed to by the promptness with which President Richard W. Parry started the meetings and the dispatch with which he conducted the business sessions. Other factors were the inclusion of a greater number of welfare topics than on last year's program, giving opportunity for a larger number of delegates to participate in the discussion, and the confining of the illustrated lectures to subjects of engineering rather than general interest. The convention headquarters, at Hotel Savery, were only four blocks from the Coliseum, where were afforded excellent facilities for the display exhibits and the holding of the convention sessions. At the mechanical exposition, held in conjunction with the convention, 101 firms in 156 booths displayed the latest and best in power-plant equipment. The total attendance at the convention was approximately 1,500, including about 340 delegates.

On Monday delegates and visitors arrived from all parts of the country, being directed to their hotels by a famous engineer band from Topeka, Kan. That evening the mechanical exposition was officially opened. Then followed an informal reception and dance at Hotel Savery.

At the first regular session on Tuesday morning, presided over by Clyde A. Bland, chairman of the local committee, the assembled engineers were welcomed by the state, the city and local Chamber of Commerce, through Governor Nate Kendall, Mayor Carl Garver and George Hamilton. Responses were made by President Parry, Frederick Felderman, national vice-president, and Alfred Johnson, past national president of the association. The meeting was then turned over to President Parry, and after the appointment of the usual committees the convention was ready to function.

Advocates Definite Membership Plan

The Tuesday afternoon session was devoted to reports of the officers and committees. For increasing and holding membership President Parry urged a broad and definite plan, covering enough time to get results. In the past, he said, there has not been enough continuity of effort to insure success. In his opinion the association's dues are inadequate to carry on the work that should be done. He recommended that the association adopt a set of definite provisions for propaganda work, as this would make it possible to keep in better touch with local branches and to send around to the various subordinate associations a number of special deputies and national officers, to inspire them to greater efforts. Every effort should be made, said President Parry, to obtain publicity for all the association's activities, and for this reason every local and state association should have a live publicity committee or agent. He said that every state deputy should be held responsible for the proper returns from all the local sections within his territory. He believes, however, that organizing new associations should not be a part of the state deputy's work, as this could be better accomplished by a special deputy selected directly by the president.

As the educational activities of the national body have not been getting the results warranted by the time, effort and money expended, President Parry suggested that the present educational committee be replaced by an educational secretary, under salary, appointed by the national president and under his control. This educational secretary would work with the editor of the *National Engineer*, preparing articles on selected subjects and answering or discussing questions of general interest submitted by members of the association.

In general, the president urged more careful selection of officers, particularly in subordinate associations. He recommended that the association's policy be changed to permit officers to hold office longer than one term, if efficient, or else to permit them to be re-elected later on, so that the best men of the organization might always be available to carry on its work.

National Vice-President Fred Felderman reported the installation of eleven new associations during the year, the reinstatement of two associations, the return of five charters and a consolidation of two locals. Reports that he had received placed the active membership of the association at 19,259. By tabulating the reports received from certain localities, Vice-President Felderman found that the average attendance for the last nine months was only 6.63 per cent. In his opinion this apparent lack of interest in association affairs should be thoroughly analyzed. With regard to the election of officials, Mr. Felderman felt that they should be elected on the basis of merit and efficiency, not on good fellowship. He recommended the consolidation of small locals where the conditions warranted such a move, and the combining of associations in educational and legislative work. He also recommended that the social affairs of the association be centralized wherever possible.

Fred W. Raven, national secretary, reported a total membership of 22,463, indicating a gain for the year of 407. By National Treasurer Samuel W. Forse, the total receipts for the year were given as $41,924.26, which was about $2,600 less than last year.

An Off Year for License Legislation

The license committee reported very little gain for 1922, as this has been an off year for legislative progress, no state or city action having been taken. A copy of the proposed bill for the state of Michigan, to be presented in 1923, had been reviewed by the committee.

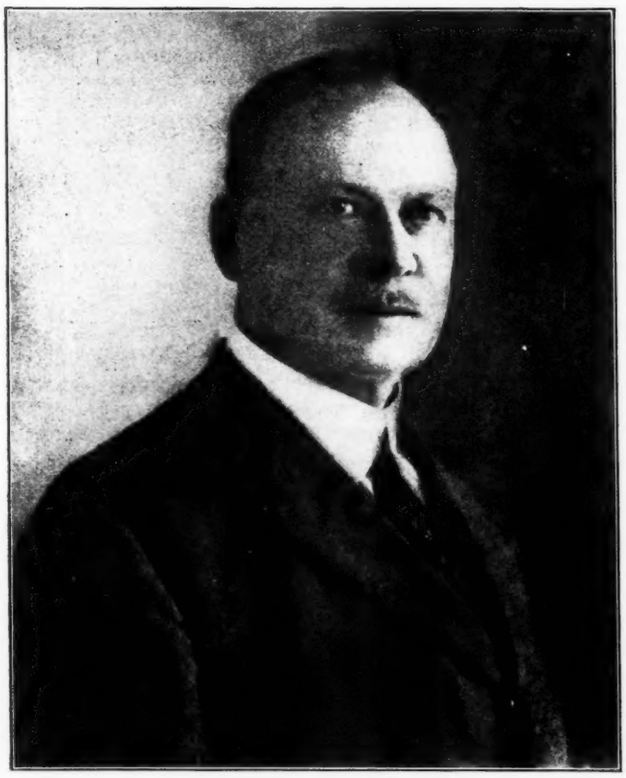
In a comprehensive review of the work of the membership extension committee, John W. Lane, editor of the *National Engineer*, emphasized the need of affiliation with chambers of commerce and similar bodies as a bridge of contact between associations and employers. During the year the membership extension committee incurred expenses of $328. For next year they recommended an appropriation of $1,000, and a salary of $300 for the secretary of the committee. They also recommended that Secretary Raven, who acted as secretary of the committee for the past year, be awarded $200.

The educational committee seconded the recommendation of President Parry that an educational secretary be appointed, to organize and co-ordinate all of the educational work of the association. To meet the salary of such a secretary and the expense of the work, the committee proposed that the semi-annual tax per capita be increased to 50 cents. In addition, the educational committee recommended that an appropiation of $1,200 be made for revising slides and lectures. As a rider to its report the committee offered for endorsement a resolution that had been passed at the Wisconsin convention, proposing that the N.A.S.E. favor the passage of a national law requiring that all coal for delivery be accompanied by a certified copy of its proximate analysis and heat value, attached to the bill of lading. The committee recommended that copies of this resolution be sent to the proper government officials and to representatives in Congress. There was much discussion of this resolution. Some thought that it would increase the price of coal and favored making an analysis of the coal after its delivery in the plant. Others pointed out that it would be too late when the coal was in the bunkers. Such a law, requiring a certified analysis of coal would be valuable, in that it would prevent the sale of inferior coal at top prices, particularly in times of shortage. The cost of making such an analysis at the mine would be about two cents a ton, and protection would be afforded the small consumer. The big buyer could always take care of himself. With the exception of moisture there would

be little variation in the analysis between mine and plant. A resolution was adopted calling for the appointment of a committee of three to confer and co-operate with the A.S.M.E. in developing standard ammonia fittings. Another resolution adopted by the convention favored greater protection from floods on the lower Mississippi River.

In a paper on recent developments in feed-water treatment, F. L. Dunham, of the Permutit Co., traced the progress in water softening during the last twenty years, outlining the equipment, operation, efficiency and trouble encountered with the early intermittent softeners. He described the continuous softening process and the hot process system employing the lime-soda treatment, finally leading up to the latest method, the zeolite process, described in *Power* for Sept. 12, page 412.

On Wednesday morning the second business session was held. The board of trustees of the *National Engineer* gave



FREDERICK FELDERMAN
Elected President of the N.A.S.E.

the total receipts for the year as $25,231.28, which was $3,764.72 less than for last year. Charles H. Bromley gave a welfare paper on "The Causes of and Remedies for Dry Rot in Associations." He emphasized the need of officers capable of visualizing the great ideas expressed in the preamble of the constitution, and of presenting these suitably before employers, chambers of commerce and other interested bodies. At conventions, he said, less time should be wasted in useless parliamentary harangue. He also placed great emphasis on the need for educational advancement. He considered the appointment of an advisory committee and greater liberality in appropriations as being essential. Mr. Bromley's address furnished the inspiration for considerable discussion. His ideas were strongly backed, and other ideas were advanced conducive to bigger and better associations. One member stated that the government census had shown that there were more than 242,000 engineers in the country. He said that the membership of the N.A.S.E. should represent more than 10 per cent of this number.

The annual outing at the state fair grounds on Wednesday afternoon was a great credit to the committee in charge. The exposition exhibitors won the ball game, but in the tug-of-war the laurels went to the engineers. That evening the National Exhibitors' Association gave their annual spread to the delegates in the Coliseum. The election returns of the National Exhibitors' Association gave Hudson Dickerman as president; A. W. France, vice-president; George Rowland, treasurer; F. N. Chapman, secretary; and E. E. Jones, W. P. Lyons, C. F. Green, I. S. Pieters and W. L. Schaeffer, members of the executive committee.

On Thursday afternoon John W. Lane spoke on another welfare topic, "The Power-Plant Engineer as a Specialist." He said that the question was whether the power-plant engineer should be satisfied to be considered a specialist in this work, or whether he should use it as a stepping stone to executive positions of management. The discussion following this address turned to the relative advantage of being a specialist in one phase of power-plant engineering or of being an "all-around good engineer." Most of those who took part in the discussion favored the latter definition.

At the business meeting on Friday morning, referendum proposals were introduced, (1) to increase the salary of the national secretary from $2,400 to $3,600, (2) to limit the mileage rate to six cents, (3) to combine the office of secretary and treasurer, and (4) authorizing the president to appoint a committee of three to revise and direct the educational work. These proposals are to be submitted through the regular channels for vote by the subordinate organizations.

New Officers of the Association

The election of officers resulted in a close contest for vice-president, Royal H. Holbrook finally being the successful candidate on the fiftieth ballot. Vice-President Frederick Felderman succeeded Richard W. Parry as president, and the other officers are: Fred W. Raven, secretary; S. B. Forse, treasurer; W. J. Reynolds, trustee for five years; Bart M. Doyle, conductor; C. A. Gordon, doorkeeper.

The Ladies' Auxiliary elected Sophie Legner as president; Florence Kimball, vice-president; Lenore W. Farmer, secretary; Mary T. Mahon, treasurer; Mary Hughes, conductor; Fleeda Wooten, doorkeeper, and Rebecca Ellis, chaplain.

Buffalo was chosen as the convention city for 1923.

Department of Commerce Gives Figures on Electrical and Mechanical Exports

A series of domestic export tables prepared by the Department of Commerce shows that for the month of June the provinces of Quebec and Ontario, Canada, were our principal customers for steam turbines, having imported 43 turbines of American make, valued at $33,844, while Japan imported only four American-made turbines, and Chile, Colombia, Uruguay and China took one apiece. France, on the other hand, bought more direct-current generators from us than any other country, while Japan took 98 per cent of our total export of 781,824 lb. of generator parts and accessories. The total quantities of each exported article listed by the Department of Commerce are given in the accompanying table.

TOTAL ELECTRICAL AND MECHANICAL EXPORTS FROM THE UNITED STATES FOR THE MONTH OF JUNE, 1922

	Number	Dollars
Electric generators, d.c.:		
Under 500 kw.	276	49,006
Over 500 kw.	36	25,059
Electric generators, a.c.:		
Under 2,000 kw.	14	17,070
Over 2,000 kw.	2	4,220
Accessories and parts for generators (781,824 lb.)	..	385,584
Electric locomotives:		
Railway	1	4,856
Mining and industrial	19	74,483
Steam turbines	52	238,545
Centrifugal pumps	171	48,257
Steam pumps	495	78,271
Other power pumps	1,804	138,190
Other pumps and pumping machinery (489,852 lb.)	..	142,463
Copper:		
Bare wire (978,781 lb.)	..	162,321
Insulated wire and cable (631,646 lb.)	..	147,974

California To Revise Its Boiler Safety Code

In 1919 the Industrial Accident Commission of the State of California decided to revise its existing boiler safety orders, in effect since Jan. 1, 1917, and accordingly requested various power interests of the state to serve on a committee for this purpose. After numerous committee meetings and four public hearings the revisions have been completed in tentative form and published under the title, "Tentativ Revised Boiler Safety Orders." The principal changes are as follows:

1. No water-tube boiler having cast-iron headers, mud drums or junction boxes shall carry a pressure in excess of 160 lb. per sq.in.

2. The tubes in fire-tube boilers must be substantially beaded at the end nearest the fire, and either beaded or flared not less than ¾ in. at the end farthest from the fire, in which case the tube shall extend through the head not less than ¼ in. nor more than ½ in. Tubes in fire-tube boilers may also be welded at either end.

3. Any boiler in which a typical "lap-seam crack" is discovered along a longitudinal riveted joint, for either butt seam or lap joint, shall be permanently discontinued from use unless the defective course is entirely renewed and the longitudinal seams of all other courses thoroughly examined after removing all rivets and separating the plates.

4. No method other than forging may be used to weld the tubes of water-tube boilers, except that small holes occurring in bags or blisters on tubes in water-tube boilers may be repaired by electric or other autogenous welding processes, when the greatest dimension of the hole does not exceed one-half inch.

5. No boiler while in active service shall be left unattended longer than thirty minutes, regardless of whether or not it is equipped with any form of automatic control.

In addition, a rule for calculating the safe working pressure on staybolted surfaces is given, and it is required that all hoods on vertical tubular boilers be provided with a door approximately rectangular in shape.

A public hearing on the revised boiler safety orders was held in San Francisco on Sept. 14, 1922, and a second hearing will be held on Sept. 19, 10 a.m., in Room 908, Pacific Finance Building, Los Angeles. The revised orders, if adopted, will supersede the boiler safety orders of Jan. 1, 1917.

Steam Utilization in Paper Mills*

By S. W. Slater and J. E. A Warner

In general, the importance of heat conservation has not been appreciated in the newsprint industry, so there is great opportunity for savings. On the basis of the old rule, "A ton of coal makes a ton of paper," the newsprint industry must have a yearly fuel demand equivalent to about two million tons of coal.

In selecting a suitable prime mover for a paper mill, the governing factor is the amount of steam required for drying the paper; consequently it does not follow that the engine or turbine having the lowest water rate is most suitable. The water rate of the prime mover, in conjunction with the initial steam pressure and quality, must also be such as to insure approximately dry exhaust steam, at the pressure of the dryer, as it is undesirable to have steam of a high moisture or superheat content entering the dryers. The condition of the exhaust steam can easily be computed if the initial condition and the water rate (per brake horsepower) of the prime mover are known. First, 2545 is divided by the water rate to get the amount of heat that must be abstracted from each pound of steam supplied to the prime mover. Subtracting this from the heat in the initial steam, we get the amount of heat in the exhaust steam, from which its condition for the given pressure is easily figured. For example, with an initial pressure of 146 lb. gage, an initial temperature of 401 deg. F. and an exhaust pressure at the dryers of 9 lb. gage, the prime mover would need a water rate of 45 lb. per brake horsepower in order that the exhaust steam should be dry saturated. A lower water rate would give wet steam and a higher water rate superheated steam.

In the past it has been difficult to obtain data showing the horsepower requirements of paper machines, but with the advent of motor drives more information is becoming available. It is impossible to give a formula that will cover all installations, for the power requirements will vary with the type and mechanical design of the machine, the conditions under which it is operated and the efficiency of transmission. The following, however, is cited to show approximately the power demand of the variable-speed drives and is based on a speed of 100 ft. per minute and a paper width of 100 in.

1. Modern high-speed motor-driven machines, having four presses, forty 72-in. dryers, and operating at speeds varying between 700 and 1,000 ft. per min.—25 to 30 hp.

2. Turbine-driven machines, rope-drive transmission, having three presses, thirty-two 60-in. dryers, and operating at speeds of 550 to 700 ft. per min.—30 to 34 hp.

3. Engine-driven machines, Marshall drive, three presses, thirty-two 48-in. dryers, and operating at speeds of from 350 to 600 ft. per min.—33 to 38 hp.

Of late much attention has been given to electric drives for paper machines, and in some recent installations the electric energy for driving is generated by a hydro-electric plant. The heat required for the dryers may then be obtained from high-pressure steam reduced through a pressure-reducing valve to a lower pressure, with consequent superheat. As has already been stated, however, superheated steam is not suitable for use in the dryer.

Use for Process in Paper Mills Makes Private Plant Desirable

Moreover, unless electrical power can be purchased at a low rate, it is not thought that such an installation is economical. The reason is that practically as much steam as before must be supplied for drying. In one typical example it was figured out that the price of electrical power could not exceed one-third of a cent per kilowatt-hour if it were to be cheaper than using a steam-driven prime mover. This was figured on the basis of an assumed cost of seventy-five cents per thousand pounds of steam. The comparison did not take into consideration the interest and depreciation on capital invested, or the maintenance and operation costs, but as the total cost of the electric drive is approximately two and one-half times that of a turbine rope-drive installation, it is thought that if these costs were considered the comparison would be even more favorable to the turbine rope drive.

The electrical installation, however, offers many advantages from the viewpoint of operation and, with the development of high-speed machines, will no doubt become the most acceptable type of drive. It is the opinion of the authors that the application of motor drive will prove most economical when the necessary electric power is developed by a turbo-generator, the exhaust of which is utilized for drying the paper. The bleeder or extraction type of turbine would have the advantage of greatest flexibility in that a minimum amount of steam would be wasted during periods of light loads, when practically no steam is required in the dryer.

The old practice of specifying paper-mill ventilation on the basis of so many minutes per air change, without due regard to the moisture liberated from the paper being dried, is not logical, as it is obvious that the amount of moisture liberated in two machine rooms of the same size might be entirely different.

The amount of heat lost to the process by the expelled ventilating air is, in all probability, the greatest unpardonable waste in the manufacture of paper. Much of this loss can be saved by employing an economizer designed to use the hot moisture-laden air leaving the room to preheat the supply of fresh air. This will not require a large temperature drop because the moist air has a high specific heat and parts with its heat readily.

*Abstract of paper to be presented at Springfield Regional Meeting of the American Society of Mechanical Engineers, Springfield, Mass., Sept. 25, 1922.

News in the Field of Power

F.A.E.S. To Take Up Muscle Shoals Question

The appointment of a committee of leading engineers to study thoroughly every phase of the Muscle Shoals problem was authorized in a resolution adopted by the executive board of the American Engineering Council at its closing session in Boston, Sept. 8.

The members of this committee are to be selected by a special committee of the executive board, appointed by Dean Mortimer E. Cooley of the University of Michigan, president of the F.A.E.S., and finally approved by the Committee on Procedure.

Calvert Townley, vice-president of the Westinghouse company, and past president of the A.I.E.E., is chairman of the Committee on Procedure. Other members of this committee are Dean Dexter S. Kimball, of Cornell University, president of the A.S.M.E.; J. Parke Channing, of New York, mining engineer; W. E. Wolfe, city engineer of St. Louis; W. W. Varney, of Baltimore; and H. E. Howe, of Washington. President Cooley said that strenuous efforts will be made to place at the disposal of the nation the services of America's best engineering ability.

To Burn Powdered Coal in Soda-Ash Plant

What is believed to be the first application of pulverized coal to the soda-ash industry is now being made at the plant of the Diamond Alkali Co., Painesville, Ohio. Powdered coal will be used for both the soda-ash dryers and the boilers. The installation comprises a drying and crushing plant and a distribution system which will convey the powdered coal through a 5-in. pipe line 750 ft. long, from crushing plant to furnaces. Thirty-two boilers of various sizes and 32 rotary dryers will ultimately be served by the powdered-coal installation. The Fuller-Lehigh Company, Fullerton, Pa., is supplying the drying, pulverizing and distributing equipment for the first unit. When completely equipped, the powdered-coal plant will handle 1,600 tons a day.

Consider Harnessing Tides of Bay of Fundy

With little or no publicity in the newspapers of eastern Canada, engineers of the Dominion government during the last few months have been investigating the tidal water-power possibilities of the Bay of Fundy, Nova Scotia. According to many seafaring men, the abnormal rise and fall of the tide in this bay—as much as 60 ft. at the northernmost end, and nowhere less than 25 ft.—is unequaled in any other known body of water. For some years it has been asserted that tidal power developments in this region would pave the way for extensive industrial development on both the New Brunswick and Nova Scotia shores, as well as in Washington and Hancock Counties of eastern Maine.

Investigators to determine the best sites for the proposed developments are being made in the Annapolis and Minas basins, the St. John, Yarmouth, Chance and Parrsboro harbors, Digby Cut, and at the mouths of the St. Croix and Petitcodiac Rivers. It is expected that the engineers' report will be published late in the fall.

Hoover Wants Strong-Arm Coal Remedy

"Something has got to be done to the coal industry with a strong right arm. There are 8,000 bituminous mines in this country with an annual capacity of 850,000,000 tons, 300,000,000 tons beyond our national needs. There are 2,500 too many bituminous mines and 200,000 too many people in the business. The public demands results; it is sick and tired of periodic warfares and futile attempts at solution of the coal problem. Certain basic changes must be made, and in making these changes we must act upon adequate, accurate information. A national coal commission can and will get this information."

—From Secretary Hoover's address before the chemical salesmen's association, Sept. 12, 1922.

July Power Output Falls Below June Record

The average daily production of electricity by public-utility plants in July was 124,000-kw-hr., a decrease of 3 per cent from the record rate of 128,000 kw.-hr. set in June. It is believed, however, that this slight decrease was due more to seasonal changes in industrial conditions than to any other cause. In hydro-electric plants the decrease was due to the smaller amount of water available during the summer months. The average daily consumption of coal during the month was a trifle less than in June, while the consumption of oil and gas increased about 5 per cent and 7 per cent, respectively.

Soft-coal production shot upward during the week of Aug. 28-Sept. 2 almost as rapidly as it plunged downward five months ago, when the strike was declared. Returns to the United States Geological Survey for the week when completed will show a production of 9,200,000 to 9,700,000 tons, as against 6,700,000 tons for the week of Aug. 21-26.

Labor Shortage Felt in New York State

Skilled labor is scarce, in some cases at a premium, common labor is almost completely absorbed and the demand for good farm hands exceeds the supply in every rural section of the state, according to the latest report of the Industrial Commissioner of New York State. The only surplus in common labor is found in locatlities where the common laborer is not willing to accept agricultural employment.

The floating element, the so-called "traveling help," which was a serious problem with the Industrial Department a year ago, has now disappeared, employment offices throughout the state finding it a difficult matter to get men to leave their home locality for employment elsewhere in the state. The textile strikes in the eastern states, notably Massachusetts, apparently have had little effect upon the New York State labor market.

Public work is being handicapped by lack of common labor at the prices fixed. Highway contracts and other public work entered into some time ago were fixed on a common labor base of 30 to 35 cents an hour. Common labor is now being paid from 40 to 55 cents an hour, and because of this increase public-work contractors are having difficulty in obtaining help of this kind at the lower rate.

Another Hydro Development Planned for Southern California

A thirty-year contract to supply the Southern Sierras Power Co., of Riverside, Cal., with 30,000,000 kw.-hr. annually for distribution in the Imperial Valley, has been signed by the San Gorgonio Power Co. This company was organized a year ago with capital stock of $1,000,000. R. R. Scarborough is president, and W. T. McAllister, M. S. Hazen, A. W. Hazen and J. A. Lamour are directors. The company's contract will be fulfilled through a $2,500,000 development on the south slope of Mt. San Gorgonio, near Riverside, consisting of a series of three plants whose sites were purchased two years ago from the Consolidated Reservoir & Power Company.

Should Represent Public Utilities on Coal Commission?

In view of the peculiar character of the coal problems of the nation's public utilities the attention of the President and of his advisers is being called to the advisability of naming as a member of the fact-finding commission just authorized by Congress someone thoroughly familiar with those problems. It is also contended that there should be at least one representative of the public utilities on the staff of the Federal Fuel Distributor.

Although the fact-finding commission will have power only to investigate and make recommendations, it is certain that its reports will have an important bearing on whether or not a strike will take place next April. The commission's study of the coal industry is most certain to be the basis of legislation. For this reason it is pointed out that the interests of such large consumers of coal as the public utilities should be considered in making an analysis of the coal industry and in settling upon the remedies for its ills.

Would Do Away With Twelve-Hour Shift

"The tendency throughout the world is toward abolition of the twelve-hour shift," asserts the report of the Committee on Work Periods of the American Engineering Council of the Federated American Engineering Societies, adopted by the Executive Board of the Council in Boston Sept. 8. The report, in effect, finds that the two-shift day of twelve hours each is not an economic necessity in American industry.

"In almost every continuous industry," says the report, "there are plants which are operating on an eight-hour shift basis in competition with twelve-hour shift plants." It is also shown that in practically every major continuous industry plants that have changed from twelve hours to eight hours have increased the quantity of production per man up to as much as 25 per cent. In a few cases, the report states, the increase has been much higher. In the steel and iron industry, which is made the subject of a special report, it was found that "the change from the twelve to the eight-hour day has secured results sufficient to compensate in whole or in part for the extra cost." Other advantages of the eight-hour day in the steel and iron industry are described as increased efficiency, better morale, elimination of the "floating gang," which is maintained to give twelve-hour men a day off a week, and greater prestige of the industry with the public.

The conclusions of the Committee on Work Periods were based on results obtained through two lines of inquiry. One inquiry, embracing the steel and iron industry of the country, was directed by Bradley Stoughton, of New York, former secretary of the A.I.M.E. and former adjunct professor of metallurgy in Columbia University. The second inquiry was directed by Horace B. Drury, industrial investigator and former member of the faculty of Ohio State University. Each inquiry was made the subject of a separate report, both being combined in the Committee's report and presented to the Executive Board by Dr. H. E. Howe, chairman of the Committee. Dr. Howe's associates on the Committee were J. Parke Channing, L. P. Alford, Fred J. Miller and Dwight T. Farnham, of New York; Morris L. Cooke, of Philadelphia, and L. W. Wallace, of Washington.

Obituary

Charles G. Armstrong, well-known consulting engineer, of New York City, died Sept. 11 at his home in Jersey City. Mr. Armstrong was the head of a firm of consulting engineers, composed of himself and his sons. He was a Mason, an Odd Fellow, and a member of the A.I.E.E., the A.S.R.E. and other refrigerating societies. At the time of his death he had just completed an oil-burning installation for James McCreery & Co., New York City.

Society Affairs

New York Section, A.S.R.E., will meet Wednesday evening, Sept. 20, at the Machinery Club, 50 Church St. The feature will be a motion picture of the "Frigidaire Domestic Refrigerator," followed by remarks from men prominent in the refrigerating field.

Coming Conventions

Society of Industrial Engineers, 29 West 39th St., New York City. National convention, New York City, Oct. 18-20.

Society of Naval Architects and Marine Engineers, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 8-9.

American Society of Mechanical Engineers, 29 West 39th St., New York City. Annual meeting at New York City, Dec. 7-13.

National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City, Dec. 7-13.

Boston Sections, A.I.E.E. and A.S.M.E., will hold a joint meeting on Oct. 3 at the Engineers' Club. Alexander Schein, of the Sperry Gyroscope Co., will present a paper on the gyroscopic stabilization of ships.

Personals

George Uhler, supervising inspector-general of the Steamboat Inspection Service, Washington, D. C., will have been a licensed engineer for 50 years on Sept. 20.

C. E. Reese, editor of the "Gas Engineering and Appliance Catalog" and associate editor of the *Gas Age-Record,* has joined the stoker sales department of the Westinghouse company at South Philadelphia. He was previously cadet engineer and combustion engineer with Henry L. Doherty & Co., and assistant engineer of the Illinois Public Utilities Commission.

Trade Catalogs

Stokers—Green Engineering Co., East Chicago, Ind. A 72-page catalog dealing with the various Green products, such as the natural- and forced-draft chain-grate stokers, Sealflex arches, steam-jet ash conveyors and cast-iron hoppers. The introductory pages review the early development of the chain grate, and in the concluding pages are found valuable data in condensed form on the classification of coals, fundamentals of combustion, furnace, chimney and breeching designs and typical boiler settings. To facilitate reference, the edition is indexed. It should prove of value to any engineer interested in combustion.

Oil Burner—F. J. Ryan & Co., Philadelphia, Pa. Bulletin 4A, entitled "Liquid Fuel Burning for the Generation of Steam," describing the Mircs low-pressure air burner.

Wave Transmission of Power—Walter Haddon, 132 Salisbury Square, Fleet St., London, E.C.4. An interesting catalog of rock drills and riveting hammers of English make, using a new principle of power transmission, that of waves or pulsations carried through a column of water in a pipe or flexible jointed hollow cable. The catalog is devoted principally to a description and explanation of the wave method of power transmission, the invention of George Constantinesco, a Rumanian engineer.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Sept. 5, 1922	Sept. 11, 1922
Pool 1,	New York		
Smokeless,	Columbus	$4.50–6.50	$5.00–6.50
Clearfield,	Boston	4.50–5.50	4.50–5.50
Somerset,	Boston	4.50–6.00	4.50–5.75
Kanawha,	Columbus	4.50–6.75	5.75–6.25
Hocking,	Columbus	5.00–5.50	5.25–6.00
Pittsburgh No. 8	Cleveland	5.00–5.50	5.00–5.25
Franklin, Ill.,	Chicago	4.50–4.75	4.50–5.00
Central, Ill.,	Chicago	4.25–4.75	4.25–4.75
Ind. 4th Vein,	Chicago	4.65–5.00	4.65–5.00
West Ky.,	Louisville	4.00–4.50	4.00–4.50
Big Seam,	Birmingham	3.50–4.50	2.60–4.00
S. E. Ky.,	Louisville	4.50–5.50	5.25–6.00

FUEL OIL

New York—Sept. 14, Port Arthur light oil, 22@25 deg. Baumé, 4c. per gal.; 30@35 deg., 5c. per gal, f.o.b. Bayonne, N. J.

Chicago—Aug. 31, for 24@26 deg. Baumé, $1.50 per bbl.; 32@36 deg., 3½c. per gal. in tank cars. f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—Sept. 12, f.o.b. refinery. Pennsylvania, 36@40 deg., 6¼c.; Kentucky fuel oil, 26@30 deg., 4¼c. per gal.; Gas oil, 32@34 deg., 2¾c. per gal.; 36@38 deg., 3c.; 38@40 deg., 3¼c.; Western, 24@30 deg., $1.30 per bbl.

Philadelphia—Sept. 11, 26@28 deg. Baumé, Oklahoma, $1.25@$1.30 per bbl.; 30@34 deg., Oklahoma (group 3), 3¼@3½c. per gal.; 16@20 deg. Seaboard, $1.50@$1.60 per bbl.

Cincinnati—Aug. 21, for 26@28 deg. Baumé, 5¼c.; Diesel, 28@30 deg. 5½c. per gal.; distillate 38@40 deg., 6c.

Cleveland — Aug. 21, 26@28 deg. Baumé, 4¼c. per gal.

New Plant Construction

PROPOSED WORK

Ala., Waterford—The Houston Power Co., Newton, plans the construction of a 3,000 hp. hydro-electric power plant here. Southern Engr. Corp., Albany, Ga., Engrs.

Calif., San Diego—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., will receive bids until Sept. 27 for training station, here, administration building, mess hall, barracks buildings and quarters, pump house, etc. Spec. 4665.

Col., Denver—The Colorado Consistory No. 1, W. M. Rees, Secy., Masonic Temple Bldg., received bids for a 3 story, 125 x 125 ft. Masonic Temple on 14th and Grant Sts., from P. Seerie, Interstate Trust Bldg., $474,353; F. Varnum, Interstate Trust Bldg., $464,672; F. H. Cowell, Central Savings Bank Bldg., $463,614; heating, J. F. Pfeiffer, 1140 California St., $63,104.

Col., Fort Collins—C. Borditz, 1311 West Mountain Ave., is in the market for a 12 hp. gasoline engine for machine shop.

Conn., Bridgeport—The Huber Ice Cream Co., 800 Seaview Ave., plans to build a 3 story ice cream manufacturing plant. Estimated cost $150,000. Fletcher-Thompson, Inc., 542 Fairfield Ave., Archts. and Engrs.

Ill., Chicago—F. J. Campbell, 68th and Merrill Sts., is having plans prepared for a 3 story, 120 x 125 ft. apartment building, including steam heating system, on 68th and Clyde Sts. Estimated cost $450,000. T. R. Bishop, 35 South Dearborn St., Archt.

Ill., Chicago—Graham, Anderson, Probst & White, Archts., 80 East Jackson St., plans to build a 21 story, 150 x 316 ft. office building, including steam heating system, on Lawrence St. Estimated cost $7,000,000. Owner's name withheld.

Ill., Chicago—E. E. Hall, Archt., 123 West Madison St., is receiving bids for a 3 story, 120 x 250 ft. apartment building, including steam heating system, on Waveland St. and Sheridan Rd. Estimated cost $400,000. Owner's name withheld.

Ill., Chicago—St. Xaviers College, 4928 Cottage Grove, is having plans prepared for a 3 story, high school including steam heating system on 49th and Cottage Grove. Estimated cost $400,000. J. W. McCarthy, 139 North Clark St., Archt.

Ill., Marshall—The city council, F. L. Archer, Clk., will receive bids until Oct. 5 for light and power plant improvements, consisting of power house, 2 a.c. generators direct connected to Corliss engines, switchboard, 2 fire tube boilers, heater and feed pumps, piping, chimney, moving and setting fire tube boiler, etc.; construction of ice plant, including furnishing and installing ice making machinery 15 ton per day capacity, distilled water plant, etc.; also water works pumping station improvements, consisting of removal old pumps, putting in new waterproof floor and walls, furnishing and installing 2 motor driven triplex pumps of 359 g.p.m. each and furnishing and erecting about 2 mi. of transmission line, including transformers and lighting fixtures from power house to pumping station. F. L. Wilcox, Chemical Bldg., St. Louis, Mo., Engr.

Ill., Oak Park—The Oak Park Trust & Savings Bank will soon receive bids for a 3 story bank and office building on Lake and Marion Sts. Estimated cost $450,000. Hoggson Bros., 485 5th Ave., New York, Archts. and Engrs.

Ia., Cedar Rapids—The Bd. Educ., J. A. Motyl, Secy., will receive bids until Oct. 2 for a 3 story, 160 x 200 ft. junior high school, including steam heating system, on 20th St. and B Ave. E. Estimated cost $475,000. B. Rugh, 811 Security Bldg., Archt. F. Tustison Co., 322 Auditorium Bldg., Minneapolis, Minn., Engrs. Noted Sept. 5.

Md., Baltimore—The Bd. Educ. will soon receive bids for high school including steam heating system, at Clifton Park. Estimated cost $500,000. R. D. Kimball Co., 15 West 38 St., New York, Engrs.

Mass., Waverly—The State Dept. of Mental Diseases, W. A. Merrill, Business Agent, State House, Boston, will soon award the contract for the construction of a 75 x 78 ft. power house, capacity three 50 kw. and one 75 kw. generating units, four 300 hp. boilers, mechanical stokers, distributing system for steam and hot water for School for Feeble Minded, here. Estimated cost $185,000 for building and equipment. One 75 kw. generating unit, will soon be purchased. C. H. Tenney & Co., 200 Devonshire St., Boston, Engrs.

Mich., Hamtramck—Dodge Bros., Jos. Campau Ave., Detroit, plan to build an 8 story, 160 x 400 ft. addition to automobile factory. Estimated cost $1,500,000. Private plans.

Mich., North Muskegon (Muskegon P. O.)—The city will soon award the contract for waterworks plant, including pumping station, 2 motor driven centrifugal pumps, 350 and 500 gal. per min. against 165 ft. head, receiving well, filtration gallery, water mains, etc. Hoad, Decker, Shoecraft & Dewey, Ann Arbor, Engrs.

Minn., St. Cloud—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., plans the construction of a U. S. Veterans' Hospital here. Estimated cost $1,500,000.

Minn., Winona—The Bd. Educ., A. H. Kressin, Clk., plans to build a school. Estimated cost $1,000,000. Croft & Boerner, 1006 Marquette Ave., Minneapolis, Archt.

Miss., Corinth—The city, M. T. Sharp, Clk., will receive bids until Sept. 26 for a complete municipal electric light and power plant. Fuller & Beard, Room 616 Title Guaranty Bldg., St. Louis, Mo., Consult. Engrs.

Miss., Gulfport—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., will soon receive bids for the construction of a U. S. Veterans' Hospital, here. Estimated cost $1,500,000.

Mo., Kansas City—The Stats Hotel Co., 311 Commerce Bldg., is receiving bids for a 10 story, 50 x 142 ft. hotel on 12th and Wyndotte Sts. McKecknieg & Trask, 719 Gloyd Bldg., Archts. W. W. Huff, 314 Interstate Bldg., Engr.

N. J., Fort Lee—The Bd. Educ. is having sketches prepared for school, including steam heating system. Estimated cost $300,000. S. Sibley, Palisade, Archt. and Engr.

N. J., Trenton—The Bd. Educ., is having plans prepared for a grade school, 2 high schools 3 and 4 including steam heating systems. Estimated costs $150,000, $200,000 and $200,000 respectively. E. Sibley, Palisade, Archt. and Engr.

N. J., Trenton—The State Bd. Educ., State House, received bids for a 32 x 86 ft. power house, with underground pump and coal room addition, to house high pressure steam plant, electric generators, refrigeration plant, etc., for the State Normal School on Model Ave., from Carlton Constr. Co., Longacre Bldg., New York, $31,537; Wills-Bills Co., 17th and Sansom Sts., Phila., $29,-983; heating, Mechanical Equipment Co., Drexel Bldg., Phila., $29,627. Deckman Power Co., Goff Bldg., Camden, $30,450. Jaehnig & Peoples, 221 13th St., Newark, N. J., $31,120; electrical, Strang Elec. Co., 214 South 7th St., Phila., $12,981. Buzby & Thomas, Bourse Bldg., Phila., $14,700.

N. Y., Brooklyn—The Bd. Educ., C. B. J. Snyder, Supt. School Bldgs., Flatbush Ave. Extension and Concord St., will receive bids until Sept. 22 for installing, heating, ventilating and temperature-regulating apparatus, etc., in P. S. 67 on Edwards St.

N. Y., Brooklyn—The 105 Court St. Corp., c/o Shampan & Shampan, Archts., 50 Court St., will soon receive bids for a 6 story, 90 x 100 ft. office building, including steam heating system, on Court and Schermerhorn Sts. Estimated cost $400,000.

N. Y., Brooklyn—The Methodist Episcopal Hospital, 6th St., will receive bids for a 100 x 145 ft. addition to hospital, including steam heating system, on 6th St. and 7th Ave. Estimated cost $450,000. Crow, Lewis & Wick, 200 5th Ave., New York, Archts. and Engrs.

N. Y., Buffalo—G. B. Walbridge, 884 West Ferry St., plans to build an office building on Court and Franklin Sts. Estimated cost $500,000. Architect not announced.

N. Y., Chelsea—The Treasury Dept., Supervs. Archt's. Office, Wash., D. C., will soon receive bids for the construction of a U. S. Veterans' Hospital, here. Estimated cost $1,500,000.

N. Y., Elmhurst (Flushing P. O.)—The Bd. Educ., C. B. J. Snyder, Supt. School Bldgs., Flatbush Ave. Ext., and Concord St., Bklyn., will receive bids until Sept. 22 for installing heating, ventilating and temperature-regulating apparatus in P. S. 102 on Van Horn St., here.

N. Y., New York—The Calma Realty Co., c/o G. and E. Blum, Archts. and Engrs., 505 5th Ave., will soon receive bids for an 11 story, 78 x 87 ft. apartment building, including steam heating system, on Lexington Ave. and 93 St. Estimated cost $350,000.

N. Y., New York—The Dept. Parks, Municipal Bldg., received bids for new southeast wing and court building for the American Museum of Natural History, 81 St. and Central Park West, from James Stewart & Co., 30 Church St., $1,069,900; Niewenhous Co., 316 East 161 St., $1,072,-250; T. Dwyer, Bway. and 216 St., $1,161,-875; steam heating and fume removal apparatus, Federal Heating Co., 300 Madison Ave., $66,431; Austin Eng. Co., 121 West 42 St., $67,372; Gilles & Geoghan, $69,090; ventilation and humidifying apparatus, Baker Smith Co., 576 Greenwich St., $19,-600; Federal Heating Co., $22,239; Austin Eng. Co., $23,772.

N. Y., New York—Hotel Roosevelt, c/o G. B. Post, Archt. and Engr., 101 Park Ave., is having sketches prepared for an 18 story, 215 x 215 ft. hotel including steam heating system, on 45th St. and Madison Ave. Estimated cost $6,000,000.

N. Y., New York—Sailor's Snug Harbor, c/o Helmle & Corbett, Archts. and Engrs., 132 West 42nd St., will soon receive bids for an 11 story apartment building, including steam heating system, on University Pl.

N. Y., Tupper Lake — The Bureau of Yards & Docks, Navy Dept., Wash., D. C., will soon receive bids for the superstructure of a U. S. Veterans' Hospital, here. Estimated cost $1,500,000. Contract for foundation has been awarded to W. M. Sutherland, Synd. Tr. Bldg., St. Louis, Mo., $42,000.

N. C., Greensboro—The city council, P. C. Painter, City Mgr., will receive bids until Oct. 10 for the construction and equipment of 6,000,000 gal. filtration plant, coagulation basin with dividing wall, capacity 1,148,000 gal. and mixing chamber, equipment includes 1,000 g.p.m. motor-operated pump. J. L. Ludlow, Winston-Salem, Consult. Engr.

N. C., Shelby—The Dover Mill Co., J. R. Dover, Pres., plans to build a cotton mill and install equipment. Estimated cost $400,000.

Ohio, Chillicothe—The Quarter Master General's Office, War Dept., Wash., D. C., plans the construction of about 30 buildings, including sewer, water and lighting systems, roads and walks, for a 400-bed neuro-psychiatric hospital at the U. S. Veterans' Bureau at Camp Sherman, here. Estimated cost $2,000,000.

Ohio, Cleveland—J. Laronge, Real Estate, 214 Williamson Bldg., plans to build a 4 story, 90 x 100 ft. commercial and apartment building, including steam heating system, on Euclid Ave. and East 63rd St. Estimated cost $250,000. Walker & Weeks, 1900 Euclid Ave., Archts.

Ohio, Cleveland—Miller & James, Erie Bldg., is in the market for a complete refrigeration plant for market house.

Okla., Bliss—The city voted $9,000 bonds for an electric lighting system.

Okla., Tipton—The Tipton Power & Light Co., is in the market for 30 hp. oil engine, belting, hangers, pulleys and bearings; also an electric light unit.

Pa., Charleroi—The West Penn Power & Traction Co., Hartje Bldg., Pittsburgh, plans to build a large power station here. Estimated cost $1,000,000.

Pa., Erie—The Bd. Educ., R. S. Scobell, Bus. Mgr., received bids for a 2 story, 203 x 303 ft. Roosevelt School, from the Wagner Constr. Co., $430,000, heating, Becker-Seidel Co., Prospect Ave., N. W., Cleveland, Ohio, $74,900.

Pa., Jeannette—The American Window Glass Co., Farmers Bank Bldg., Pittsburgh, is having plans prepared for addition to plant. Estimated cost $1,500,000. Private plans.

Pa., Lancaster—The Black Strap Fuel & Potash Products Co., P. G. Hildebrandt, Pres., 505 Chestnut St., Phila., have purchased 40 acres of land near city filtration

plant and plan the erection of buildings for the manufacture of special machinery to obtain potash from waste products.

Pa., Phila.—The city received bids for a sewerage pumping plant from Jackson & Co., 119 South 4th St., $153,900; McLean Constr. Co., Commercial Trust Bldg., $244,000; Geo. L. Dobbins Co., $230,000. Noted Aug. 29.

Pa., Phila.—N. Raidman, 5130 Walnut St., is receiving bids for a 4 story, 50 x 100 ft. apartment building, including steam heating system, on Pine and 48th Sts. Estimated cost $250,000. Simon & Simon, 249 South Juniper St., Archts.

Pa., Pittsburgh—The Schenley Apts. Co., 3929 Forbes St., will soon award the contract for a 10 story apartment hotel, on Forbes, Fifth and Bigelow Sts. Estimated cost $3,500,000. Rutan, Russell & Wood, Century Bldg., Archts.

Tex., Grand Prairie—The Grand Prairie Gravel Co., is in the market for a 75 hp. boiler.

Tex., La Feria—The Water Imp. Dist. 3, A. W. Amthor, Mgr., will receive bids until Sept. 27 for diesel or semi-diesel type engine for 36 in. Worthington volute pump, also separate bids for diesel or semi-diesel type engine direct connected to centrifugal volute pump second lift.

Va., Richmond—The Medical Arts Bldg. Co., is having plans prepared for a 7 story, 52 x 150 ft. office building. H. T. Barnham, Chamber of Commerce Bldg., Archt. W. B. Bates, Moore Bldg., Richmond, and Hutton & Schreffler, Citizens Bank Bldg., Raleigh, Engrs.

Va., Richmond—The Merchants Cold Storage & Ice Mfg. Co., N. Old, Jr., Mgr., 208 South 6th St., plans to make improvements to plant, including remodeling of present building, installing unaflow engines and compressors, new boiler plants, 120 ton ice making plant, motors, etc. About $250,000. Ophuls & Hill, Inc., 112 West 42nd St., New York, Consult. Engrs.

Wash., Seattle—F. D. Black, Inc., Colman Bldg., plans to build a 3 story factory to be occupied by two manufacturing firms, also 2 heating plants, on Railroad Ave. and Connecticut St. Estimated cost $150,000. J. R. Nevins, Hoge Bldg., Archt.

W. Va., Huntington—The Stroehman Baking Co. is in the market for power equipment, conveying machinery, etc.

Wis., Camp Douglas—The Wisconsin Natl. Guard, c/o Major Orlway, plans the extension of heating system, including the laying of about 1,500 ft. of conduit. Estimated cost $25,000. H. C. Hengels, 445 Milwaukee St., Milwaukee, Engr.

Wis., Hartford—W. B. Place & Co., plan build a 3 story, 60 x 160 ft. tannery, boiler and power house. Estimated cost $100,000. Private plans.

Wis., Milwaukee—E. A. Ertel, 1466 14th St., is in the market for an electric or a belt driven air compressor.

Wis., Plymouth—The Phenix Cheese Co., R. A. Harbalt, Mgr., plans to build a 5 story, 60 x 130 ft. factory and 300 hp. electric power plant and artificial ice plant. Estimated cost $100,000. Architect not selected.

B. C., Vancouver—Adhuson & Dill, 325 Howe St., representing a syndicate, has applied for franchise to build a central heating plant and distributing system. Estimated cost $500,000 to $1,000,000. W. Leche, 1090 Howe St., Engr.

Ont., Hull—The Hull Electric Railway, G. G. Gale, Mgr., plans developments at Paygou Falls on the Gatineau River, to furnish 150,000 hp. electrical energy to Ottawa and district.

CONTRACTS AWARDED

Calif., Berekley—The University of Calif., Dept. Mechanical Engr., awarded the contract for a 1 story, 40 x 100 ft. building for housing apparatus of the heat power laboratory, including pump pit, piping tunnel and conduit trenches, to McGinty & Son, San Francisco. Equipment, consisting of one 150 hp. 350 lb. steam pressure experimental boiler, set to fire oil or powdered coal, equipped with complete control apparatus, 15 hp. gas fired boiler and engine, 50 hp. marine compound engine with integral condenser, 25 kw. turbo generator with condenser, 75 hp. Uniflow steam engine and condenser, Frick Corliss engine, straight line engine, Westinghouse gas engine, semi-diesel engine, variable compression gas engine, four different types of gasoline engines, refrigeration plant, air compressor plant and usual auxiliary heat power apparatus for fundamental experiments in nozzles, fluid flow, injectors, pressure drops, valve gears, governors, dynamometers, compressed air, meters, calorimetry and including four 10,000 lb. automatic water weighing machines and 5 ton crane to be installed. Dean C. L. Cory, College of Mechanics, University of Calif., Engr.

Calif., Marysville—The Yuba Development, Hobart Bldg., San Francisco, awarded the contracts for the Bullards Bar project, as follows: one vertical shaft hydraulic turbine, 150,000 lbs., c.i. spiral flume, bronze runners, hollow steel shaft to Worthington Co., Sharon Bldg., $32,550; 3 outdoor type water cooled transformers, 2,725 kva. a.c., 84,000 lbs. and one 1,825 kva. a.c. generator to operate under 170 to 183 ft. head, to the Allis-Chalmers Co., Rialto Bldg., $10,358 and $41,700 respectively; switchboard for complete control, Westinghouse Elec. & Mfg. Co., 1st Natl. Bank Bldg., $6,628; furnishing and delivering butterfly valve, net area of opening equal to 8 ft. dia. circle, to be operated by a 7½ hp. electric motor under a 50 ft. head with 12 in. by-pass, gross weight 46,000 lbs. to S. Morgan Smith, 461 Market St., $5,190, contractors all of San Francisco.

Conn., Devon (Milford P. O.)—The Connecticut Light & Power Co., West Main St., Waterbury, awarded the contract for power plant unit on the Housatonic River, here, to the J. A. P. Crisfield Constr. Co., Gravers Lane, Phila., Pa. Estimated cost $2,000,000.

Fla., Quincy—The city awarded the contract for improvements to water works and electric light plant, including equipment, etc., to Burford, Hall & Smith, 3rd Natl. Bank Bldg., Atlanta, Ga., $40,000. Noted Aug. 1.

Md., Baltimore—The city awarded the contract for a group of 9 buildings, administration, 3 pavilions, nurses' home, kitchen, laundry, power house and garage, including equipment, also excavations, grading, roads, sewers, etc., for Baltimore Hospital for Communicable Diseases, on Hillen Rd., to the Price Constr. Co., Maryland Trust Bldg., $658,600. Noted Sept. 5.

Mass., East Douglas—The Hayward Woolen Co. awarded the contract for a 1 story, 25 x 40 ft. addition to power plant, including new boilers, to the L. E. Locke & Sons Co., South Union St., Lawrence. Estimated cost $10,000.

Mass., Everett—The Boston Elevated Ry. Co., 108 Massachusetts Ave., Boston, awarded the contract for two 160 x 300 ft. and two 53 x 56 ft. car repair shops and an 80 x 731 ft. transfer shop here, to the Simpson Bros. Corp., 166 Devonshire St., Boston. Estimated cost $3,000,000.

Mass., Medford—The Bd. Educ. awarded the contract for a 3 story high school on Harvard and Yale Sts., to Coblo & Griffith, 46 Cornhill, Boston. Estimated cost $350,000. Steam heating and modern ventilating systems will be installed. Noted June 13.

Mass., Newton — Boston College, W. Deolin, Pres., awarded the contract for a 3 story, 140 x 175 ft. science building, on Commonwealth Ave. and College Rd., to Walsh Bros. Co., 150 Hampshire St., Cambridge. Estimated cost $400,000. Steam heating system will be installed.

Mich., Detroit—The Ford Motor Co., Highland Park, awarded the contract for a 1 story, 245 x 1,570 ft. factory, including steam heating equipment, on Livernois Ave., to the Walbridge Aldinger Co., 3356 Penobscot Bldg. Estimated cost $750,000. Noted July 18.

Mich., River Rouge (Detroit P. O.)—The Ford Motor Co., Highland Park, awarded the contract for a 5 story, 60 x 300 ft. addition to tractor and auto plant, including steam heating system, to E. Winters, 752 Book Bldg., Detroit. Noted Aug. 1.

Minn., Detroit—The city, E. J. Bestick, Clk., awarded the contract for enlarging power station and building chimney to the Gauger-Korsmo Constr. Co., 301 Endicott Bldg., St. Paul, $16,500 and $3,960 respectively. Noted Aug. 29.

Minn., Royalton—The city awarded the contract for deep well pump and accessories, to J. G. Robertson, 2542 University Ave., St. Paul, $3,124. Noted Aug. 29.

N. H., Salmon Falls—Salmon Falls Mfg. Co. awarded the contract for a 1 story, 30 x 80 ft. power house and hydro-electric plant, 1,800 hp. capacity, also redevelopment of the Salmon Falls, to the Central Engr. & Constr. Co., Central Falls, R. I. Estimated cost $250,000.

N. J., Little Falls—The city awarded the contract for sewerage system to the Sanitary Constr. Co., 66 Beckwith Ave., Paterson, $4,196, enlarging sewage disposal works and constructing pumping station to M. Averill, 196 Woodside Ave., Newark, $18,939 and $9,137 respectively.

N. J., Long Branch—The Bd. Comrs. awarded the contract for extending sewer system also building pumping station, to the Monmouth Contracting Co., Red Bank, $18,000.

N. J., Trenton—The city awarded the contract for a 1 story, 50 x 75 ft. addition to pumping station on River bank, to W. Wicks, 1402 West State St., $9,714. New machinery will be installed.

N. Y., Cohoes—C. L. Cadle, Supt. Pub. Wks., State Capitol, Albany, received bids for the construction of power house at Cresent Dam, under Contract A-3, from Brown, Lowe & Law Bros., Foster Ave., Schenectady, $329,886, Eastover Constr. Co., Herkimer, $334,995, Troy Public Works Co., U. C. N. Bank Bldg., Utica, $340,474. Contracts awarded to lowest bidder. Noted Aug. 29.

N. Y., New York—Julius Tishman & Sons, Inc., 280 Madison Ave., will build by separate contracts, a 9 story, 100 x 100 ft. apartment building, including steam heating system, at 146 West 55th St. Estimated cost $1,000,000.

Ohio, Shaker Heights—The Bd. Educ., J. W. Main, Clk., awarded the contracts for a 2 story, 136 x 152 ft. grade school on Woodbury Rd., to Parrish Bros., Wick Ave., Youngstown, $198,750; steam heating system to the Spohn Heating & Ventilating Co., 1775 East 45th St., Cleveland, about $51,250.

Okla., Walters—The Wichita Pipe Line Co. will construct and lay 22 mi. of 6 in. pipe line from here to Empire City in the Duncan Oil Field. Prices wanted on pumping and sub-station machinery and equipment.

Pa., Erie—J. M. Gannon, Bishop of Erie, Catholic Diocese, awarded the contract for an orphanage for St. Joseph's Home for Children, to Kirschner Bros., $346,000. Noted July 25.

Pa., Waynesburg—The Citizens Natl. Bank awarded the contract for a 3 story, 60 x 180 ft. bank and office building on High and Washington Sts., to M. Zeisler, 79 Wall St., New York. Estimated cost $275,000.

Va., Richmond—The state awarded the contract for an 8 story state office building on 12th and Bank Sts., to the John T. Wilson Co., Inc., Mutual Bldg. Estimated cost $850,000.

Wis., Oconto Falls—The Union Mfg. Co. awarded the contract for the construction of a steel and concrete dam to increase power, to W. E. Ule, 603 Clark St., Stevens Point. Estimated cost $25,000.

Wis., Peshtigo—The Peshtigo Paper Co., J. Sutherland, Pres., Dayton, Ohio, awarded the contract for a 68 x 150 ft. unit to paper factory, including boiler room and 2 tube boilers, to W. E. Ule, 603 Clark St., Stevens Point. Estimated cost $70,000.

Wis., Platteville—The city, c/o J. Harms, City Hall, will build, by day labor, a 1 story, 50 x 95 ft. boiler and pump house, several boilers will be required. Estimated cost $40,000. H. Kleinhammer, Archt.

Wis., Sheboygan—The Phoenix Chair Co., South 12th St. and Virginia Ave., awarded the contract for a 1 story, 60 x 60 ft. engine house and equipment, to the Jones & Laughlin Steel Co., 440 West Lake St., Chicago, Ill. Estimated cost $40,000.

B. C., Elko—The Wigwam Pulp & Paper Co. awarded the contract for a complete sulphite paper making plant, 100 ton per day capacity, 25,000 hp. power house and dam at Phillips Bridge, to McDougall & McNeill, Ltd., 514 Standard Bldg., Vancouver, $3,000,000, total estimated cost $10,000,000.

Ont., Kitchener—The School Bd. awarded the contract for a 3 story, 185 x 250 ft. technical school on King St. W., to Anglin Norcross, Ltd., Continental Life Bldg., Toronto, estimated cost $375,000; heating and power to Purdy Mansell, Ltd., Toronto. Noted May 16.

Ont., Port Credit—The council awarded the contracts for pumping station reservoir and slow sand filter to G. B. Moogk, Weston, mains, to the National Iron Corp., Cherry St., Toronto, chlorinating equipment, Wallace & Tiernan, 73 Adelaide, East Toronto, overhead tank, Des Moines Steel Co., Chatham. Estimated cost $45,000. Noted Aug. 15.

Que., Montreal—The Notre Dame Hospital, Notre Dame St., East Montreal, awarded the contract for a 6 story, 44 x 137 ft. main hospital building and 44 x 180 ft. wing, on Sherbrooke St., here, to A. Gratton, 142 5th Ave., about $450,000; heating, ventilating, refrigerating, etc., to Garth & Co., Craig St. West.